2.1 GEOGRAPHY

The Prescott Active Management Area (PRAMA) encompasses 485 square miles in Yavapai County Arizona. It lies within the Central Highlands physiographic province and is typified by gently rolling topography with broad sloping alluvial basins and fault-block mountains (Figure 2-1). Elevations range from about 4,400 feet above sea level in the valleys to about 7,800 feet above mean sea level (AMSL) in the Bradshaw Mountains. Native vegetation varies from high desert grassland in the basin areas to coniferous forest in the surrounding mountains.

The PRAMA consists of two sub-basins, the Little Chino (LIC) and the Upper Agua Fria (UAF), which are bisected by a surface drainage divide. Granite Creek and Willow Creek comprise the major tributaries draining the Little Chino Sub-basin into the Verde River. Lynx Creek and the Agua Fria River drain the Upper Agua Fria Sub-basin. With the exception of small perennial stretches at Del Rio Springs and along a short reach of the Agua Fria River in the vicinity of Humboldt-Dewey, all surface drainage in the PRAMA is either ephemeral or intermittent. The Little Chino Sub-basin encompasses the northwestern half of the PRAMA, while the Upper Agua Fria Sub-basin covers the southeastern half of the PRAMA.

2.2 CLIMATE

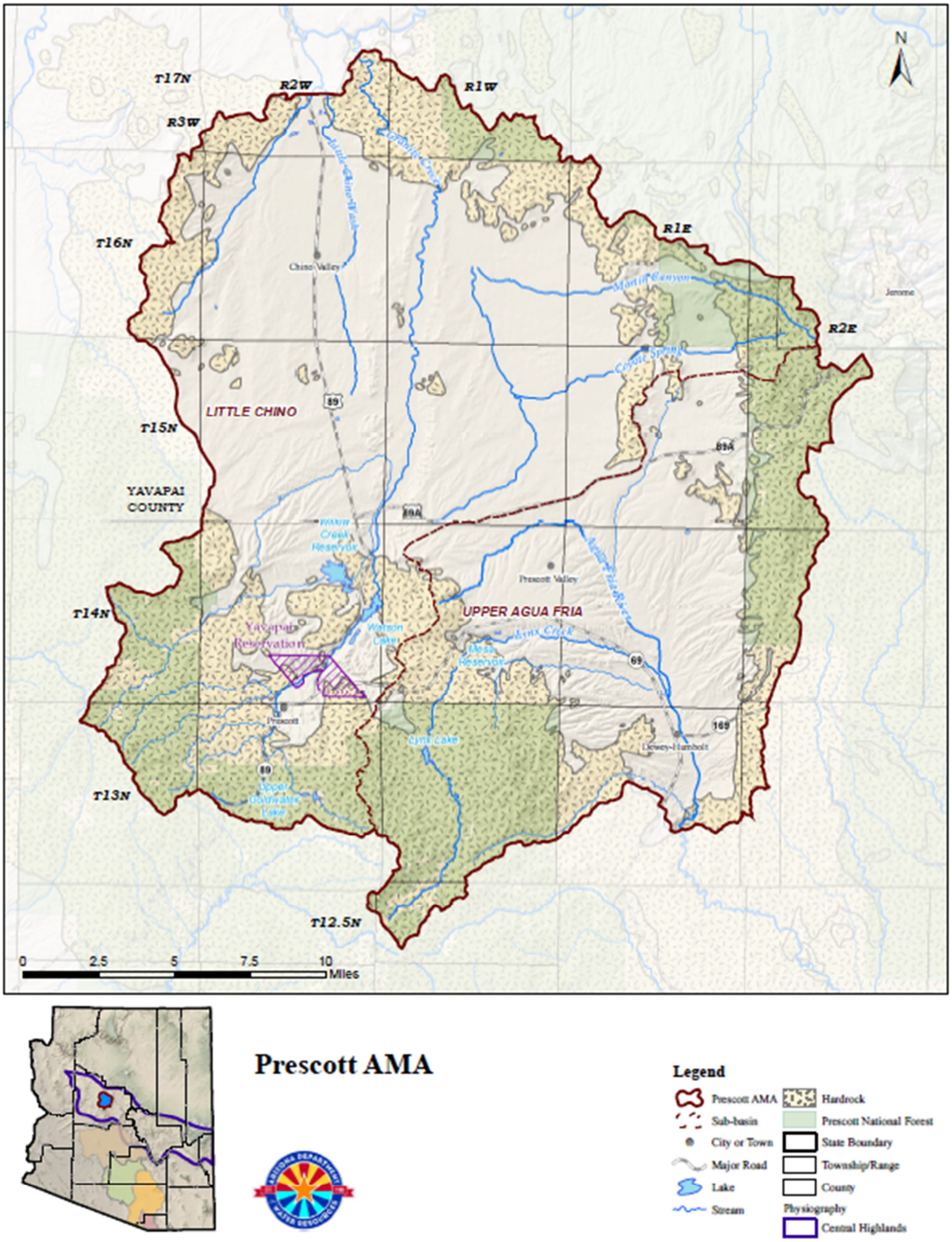
Annual precipitation is not uniformly distributed throughout the PRAMA. The distribution of precipitation in the PRAMA is influenced by elevation and orographic effects. In general, precipitation is highest in the upper elevations of the mountains that define the basin and lowest in the valleys.

Annual precipitation statistics for the Prescott weather station #026796 were reviewed for the 4MP. Since 1948, the station has apparently been located in a few different locations in the Prescott area that have a range of elevations from 5,515’ AMSL to 5,205’ AMSL. Current station location is at elevation of 5,205’ AMSL. Historical precipitation data for the PRAMA indicate that over a 110-year period of record (1899-2010), the mean annual precipitation rate in the PRAMA was 18.8 inches per year, with a median rate of 17.8 inches per year. Annual precipitation varies considerably. A shorter-term average taken from 2000-2009 is 14.5 inches per year and reflects the impacts of drought. There is a bimodal distribution throughout the year. The summer rainfall season, ranging from May to September, produced a long-term average rainfall of about 8.5 inches per year. Most of this seasonal rainfall typically occurs during the monsoon season (June-September), when long-term rainfall averaged about 7.6 inches per year. Significant precipitation also results from winter frontal storm events that often develop across northern and central portions of Arizona, although the frequency and intensity of these storms vary substantially year to year and from location to location.

Chino Valley precipitation is measured at station #021654. Over time, this station has also changed locations. The locations for this station in the Chino Valley area range in elevations from 4,750’ AMSL to 4,672’ AMSL. The current station location is at an elevation of 4,750’ AMSL. Average annual precipitation near Chino Valley is lower than it is near the City of Prescott. From 1941 to 2009, Chino Valley received an average of 11.5 inches of precipitation per year. Unfortunately, complete annual precipitation records are unavailable for most years after 1981. Given the lack of data during a dry period, this average likely is higher than if the full 58-year period were available. Chino Valley’s lower rainfall is partially attributed to its lesser average annual snowfall amounts compared to what occur in the City of Prescott.

Much of Arizona has experienced prolonged drought conditions since 1995. From 2002 to 2004, many parts of the state experienced exceptional drought conditions. Bark beetle infestations and wildfires caused major damage statewide, including portions of the PRAMA. Long-term drought conditions ranged from moderate to severe in the PRAMA from 2006 to 2010. Continued drought has the potential to impede efforts to provide a safe and secure supply of water to the water users of the PRAMA.

FIGURE 2-1
PRESCOTT ACTIVE MANAGEMENT AREA



2.3 SURFACE WATER RESOURCES

The surface water system in the PRAMA is characterized by numerous ephemeral streams, which flow only in direct response to precipitation or snowmelt, that carry snow melt and rainfall from the mountains that bound the PRAMA. Much of the ephemeral stream flow reaching the basins of the PRAMA infiltrates and recharges the underlying groundwater system before exiting the basins. However, some stream flow does exit the PRAMA along both Granite Creek and the Agua Fria River depending on the magnitude and timing of runoff.

Granite Creek, Willow Creek, Little Chino Creek, Lonesome Valley Draw, and Big Draw are the primary ephemeral streams which drain the mountains of the Little Chino Sub-basin (Figure 2-1). Granite Creek and Willow Creek drain the southwestern portion of the PRAMA. Dams were constructed on both Granite Creek (1914) and Willow Creek (1939), forming Watson Lake and Willow Lake, respectively. In 1998 Chino Valley Irrigation District's (CVID) surface water rights were severed and transferred to the City of Prescott for municipal use within the City's water service area, and non-consumptive (in situ) use for recreation, and wildlife, including fish for water held in storage

During periods of prolonged precipitation and flooding, flows from these lakes join at the confluence of Granite and Willow Creeks and then flow northward to join the Verde River several miles southeast of Paulden. Such flow events can provide significant recharge to the groundwater system when they occur. Little Chino Creek and Big Draw drain the northwestern part of the Little Chino Sub-basin. Little Chino Creek drains the CVID area and flows into the Del Rio Springs area where these surface flows join the groundwater discharge from the springs. In this area, spring discharge provides near-permanent baseflow conditions below the springs. Lonesome Valley Draw drains the eastern half of the Little Chino Sub-basin.

Lynx Creek and the Agua Fria River are the primary surface water drainages in the Upper Agua Fria Sub-basin of the PRAMA. Flow on Lynx Creek is normally impounded by Lynx Creek Dam at Lynx Lake, constructed for recreational purposes in 1952. Stream flow in Lynx Creek below Lynx Lake provides recharge to the Upper Agua Fria Sub-basin and, if substantial, joins the Agua Fria River near Highway 89 about 2 miles north of Dewey. Below its confluence with Lynx Creek, the Agua Fria River flows in a southerly direction, exiting the PRAMA southeast of Humboldt. Perennial to intermittent flow conditions exist along portions of the reach of the Agua Fria River between the Prescott Valley Wastewater Treatment Facility and the Dewey area. Perennial baseflow conditions exist south of Dewey where the alluvial aquifer pinches out against the basement unit and groundwater is discharged to the channel of the Agua Fria River near Humboldt.

TABLE 2-1
SUMMARY OF SELECTED USGS ANNUAL STREAM GAGE DATA
PRAMA AND VICINITY

	Granite Creek below Watson Lake near Prescott 9503300	Del Rio Springs near Chino Valley 9502900	Agua Fria River near Humboldt 9512450	Verde River Near Paulden 9503700
Long-Term Mean (CFS)	4.4	1.5	5.7	43.7
Long-Term Mean (AF/YR)	3,208	1,054	4,096	31,658
Long-Term Median (CFS)	1	1.4	4.5	28.4
Long-Term Median (AF/YR)	705	1,021	3,252	20,556
Number of Years in LT Record	11	14	10	47
Earliest Year of Record	2000	1997	2001	1964

Table 2-1, provides a summary of USGS annual stream flow data available for selected gages in and near the PRAMA.

2.4 HYDROGEOLOGIC UNITS AND AQUIFER CHARACTERISTICS

The Little Chino Sub-basin comprises the northwestern portion and the Upper Agua Fria Sub-basin comprises the southeastern portion of the PRAMA. The geologic structure of these sub-basins is characterized as a deep structural trough that extends north-northwest for a distance of about 25 miles from near Humboldt in the southern part of the Upper Agua Fria Sub-basin, to near Del Rio Springs in the northern part of the Little Chino Sub-basin. The trough was formed by basin-and-range faulting and warping in both sub-basins, which gradually filled with alluvial sedimentary and volcanic rocks.

In many areas, the basin-fill deposits contain groundwater and host a productive aquifer system. The aquifer system in the PRAMA is defined by three hydrogeologic units, the Basement Unit, the Lower Volcanic Unit, and the Upper Alluvial Unit. Figure 2-2 is a conceptual drawing showing groundwater flow within these hydrogeologic units.

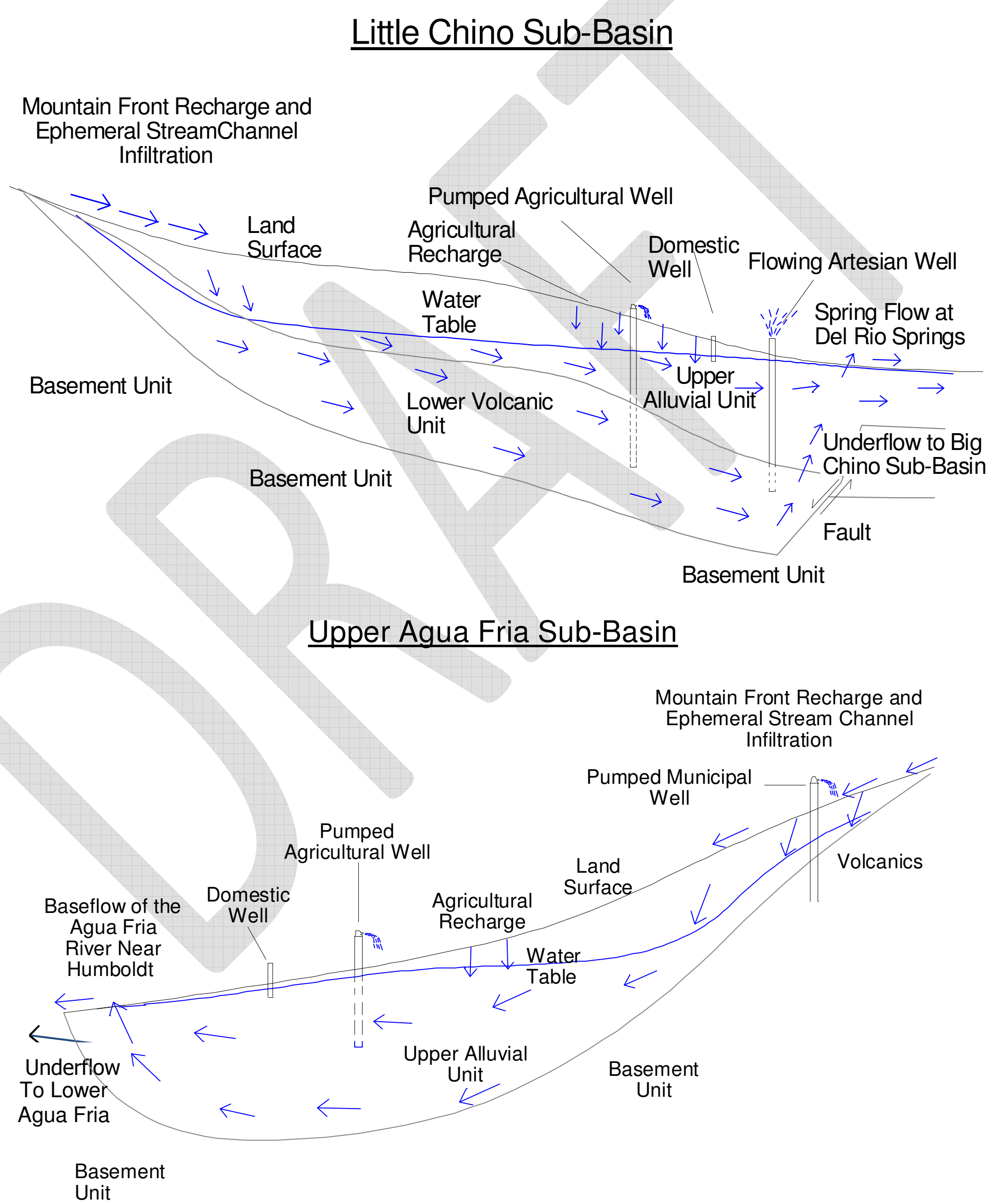
2.4.1 Basement Unit
The Basement Unit (BU) is composed of a variety of igneous and metamorphic rocks that are generally dense, non-porous, and nearly impermeable (Wilson, 1988). It forms the impermeable floor and sides of sub-basins and is exposed at the land surface throughout the mountainous areas which surround the sub-sub-basins. There are a large number of domestic wells tapping into fissures and cracks in the Basement Unit. However, the Basement Unit has very limited groundwater storage and production capacity, and is regarded as a viable aquifer for other than domestic purposes. The Basement Unit generally underlies the Lower Volcanic Unit within the Little Chino Sub-basin, and underlies the Upper Alluvial Unit in most of the Upper Agua Fria Sub-basin.

2.4.2 Lower Volcanic Unit
The Lower Volcanic Unit (LVU) overlies the Basement Unit in most of the Little Chino Sub-basin. It is composed of a thick sequence of basaltic and andesitic lava flows inter-bedded with layers of pyroclastic and alluvial material. The Lower Volcanic Unit, sometimes referred to as the basalt aquifer or layer, forms a highly productive confined (artesian) aquifer in the northwestern portion of the Little Chino Sub-basin. Many high-capacity irrigation wells (1,000-3,000 gallons per minute) tap into this aquifer system. Some of these high-capacity wells are included in the Prescott municipal well field, while a number are used for agricultural irrigation in and around the CVID.

The areal extent of the Lower Volcanic Unit is not well known in many other parts of the PRAMA. However, a high capacity production well has been drilled into volcanic deposits located near the City of Prescott airport recharge facility. Productive volcanic deposits have also been penetrated by some of the wells drilled in the Lonesome Valley and Prescott Valley areas. The total thickness of the Lower Volcanic Unit is not well known, except at a few locations where wells have been drilled through the unit's entire thickness. The productive thickness of the Lower Volcanic Unit is estimated to range from less than 100 feet up to several hundred feet. These estimates are based on the average depth-of-penetration of wells tap water from the Lower Volcanic Unit and from depth-to-bedrock maps produced from gravity data (Oppenheimer & Sumner, 1980). Depth to bedrock in the PRAMA area is estimated by a variety of data reports including: (Oppenheimer & Sumner, 1980), (Krieger, 1965); (Langenheim & etal, 2005).

A thick sequence of fine-grained materials overlies the Lower Volcanic Unit in much of the PRAMA. These deposits tend to restrict the vertical movement of groundwater, limiting groundwater flow to the cracks or fractures in these volcanic deposits (i.e., secondary porosity). Natural recharge to the Lower Volcanic Unit aquifer occurs mainly through infiltration of runoff in ephemeral stream channels and the mountain fronts of the Little Chino Sub-basin. In unconfined areas, where the overlying Upper Unit aquifer is unsaturated, recharge may directly reach the water table through deep percolation. In outlying areas, where the Upper Alluvial Unit aquifer is saturated and confining layers do not exist, recharge may reach the Lower Volcanic Unit aquifer through vertical groundwater flow. In other small areas where there are basalt outcrops, precipitation may move downward through openings and crevices reach the Lower Volcanic Unit aquifer (Schwalen, 1967). Other sources of recharge to the Lower Unit aquifer include incidental recharge from irrigation, canal seepage, and Prescott's artificial recharge project in the southwestern portion of the Little Chino Sub-basin.

FIGURE 2-2
CONCEPTUAL MODEL OF GROUNDWATER FLOW
PRAMA AQUIFER SYSTEM



Natural discharge from the Lower Volcanic Unit out of the PRAMA occurs at two locations in the Little Chino Sub-basin. Near Del Rio Springs, the hydraulic head or pressure in the Lower Volcanic Unit is greater than the head in the Upper Alluvial Unit. In this vicinity, groundwater flows upward from the Volcanic Unit and is eventually discharged to the surface at Del Rio Springs. Minor groundwater may also leave the PRAMA through the bedrock gap just northwest of Del Rio Springs.

2.4.3 Upper Alluvial Unit

The alluvial unit contains both saturated and unsaturated rock. The Upper Alluvial Aquifer is limited to the saturated deposits. Thick deposits of sedimentary and volcanic rocks fill the deep structural trough which extends northwest-southeast across the entire length of the Little Chino and Upper Agua Fria Sub-basins. These rocks are collectively referred to as the Upper Alluvial Unit. Where saturated, the Upper Alluvial Unit constitutes the main, unconfined aquifer in the PRAMA.

Natural recharge to the Upper Alluvial Unit is derived from the infiltration of runoff in ephemeral stream channels and along the mountain fronts of the PRAMA. Agricultural irrigation also recharges the Upper Alluvial Unit. Artificial recharge of reclaimed water at the City of Prescott's airport recharge site, Prescott Valley's Agua Fria Recharge Facility, and the Town of Chino Valley's Old Home Manor Recharge Facility are other sources of aquifer replenishment.

Production capacities vary substantially for wells in the Upper Alluvial Unit. In many instances, the are governed more by pump size (limited by well diameter) than the aquifer's ability to produce water (Remick, 1983). In the Little Chino Sub-basin, the Upper Alluvial Unit has been tapped mainly by numerous small-capacity domestic wells with less than 35 gallons-per-minute (gpm) capacity. In the Agua Fria Sub-basin, in addition to shallow domestic wells, large agricultural and municipal wells with pump capacities ranging from 100 to 3,000 gpm also tap into this aquifer (Wilson, 1988); (Wellendorf, 1994).

Natural discharge from the Upper Alluvial Unit occurs at three locations in the PRAMA. In the Little Chino Sub-basin, natural discharge occurs as spring flow at Del Rio Springs and as underflow through a bedrock gap located immediately to the northwest of Del Rio Springs. In the Upper Agua Fria Sub-basin, natural discharge occurs as perennial baseflow along the Agua Fria River near Humboldt. Recent groundwater modeling studies also indicate that there may be some groundwater underflow from the Upper Agua Fria Sub-basin through cracks and faults within the Basement Unit in the Humboldt area.

2.5 GROUNDWATER RESOURCES

2.5.1 Historical Water Use

Groundwater withdrawals haves impacted groundwater conditions in the PRAMA since the early 1940s when the use of artesian water from flowing wells and groundwater pumping for irrigation in the Little Chino sub-basin began to cause seasonal impacts (water level declines and reductions in spring discharge) that became a matter of concern to water users (Schwalen, 1967). Groundwater pumping for irrigation purposes in the Upper Agua Fria Sub-basin may have occurred as early as 1936 (Wigal, 1988).

Use of groundwater for irrigation in the Little Chino Sub-basin continued to increase from the 1940s to 1970s, resulting in significant local water level declines. Groundwater use for irrigation peaked in the 1960s, and diminished through the 1970s and 1980s (Corkhill & Mason, 1995). Between 2000 and 2010, groundwater pumping for agriculture averaged about 3,400 acre-feet per year in the PRAMA. By 2010, groundwater pumping for agriculture had decreased to about 1,600 acre-feet.

Groundwater pumping for municipal use (including domestic well pumping) has increased with growth. The City of Prescott was unable to supply itself with local supplies since at least the late 1940s began to pump and import groundwater from the Chino Valley area. Since that time, municipal pumping the City of Prescott, the Town of Prescott Valley and numerous other smaller water providers and wells have contributed to overall water level declines in the PRAMA. Between 2000 and 2010, groundwater pumping for municipal purposes averaged about 14,600 acre-feet per year. In 2010, groundwater pumping was roughly 13,000 acre-feet.

During the last two decades, the City of Prescott (Airport Recharge Facility) and the Town of Prescott Valley (Agua Fria Recharge Facility) began to recharge and directly use reclaimed water. Recharge and any direct use(s) of reclaimed water that may have replaced existing groundwater uses have contributed to local groundwater recoveries. From 2000 to 2010, the direct use of reclaimed water averaged about 1,700 acre-feet per year, and the 2010 total was about 1,900 acre-feet. During the last decade the City of Prescott also recharged some surface water (from the Granite and Willow Creek watersheds) at its Airport Recharge Facility. Some of the credits earned from those recharge activities were later recovered by CVID wells for farming activities within the district. Since 2005, the Town of Chino Valley has also recharged about 600 acre-feet of reclaimed water at its Old Home Manor Recharge Facility.

Groundwater use for industrial purposes also impacts groundwater levels. Between 2000 and 2010, industrial groundwater pumping averaged about 1,400 acre-feet per year. In 2010, industrial groundwater pumping was about 1,100 acre-feet. Most of the industrial groundwater use in the PRAMA is by turf-related facilities or by facilities that have no specific conservation requirements in the management plan, which ADWR refers to in the Assessment budget template as "Other" industrial users.

2.5.2 Net Recharge

Groundwater recharge is an important component of the water budget of the PRAMA. When groundwater recharge exceeds groundwater pumping in an area, water levels will rise. For the purposes of this discussion, recharge is comprised of the following natural and incidental components: (1) mountain front recharge, (2) stream channel recharge, (3) groundwater underflow (outflow), (4) groundwater discharge, (5) riparian evapotranspiration (ET), (6) canal recharge and (7) agricultural return flow (agricultural recharge).

The major sources of natural recharge in the PRAMA are (1) mountain front recharge and (2) stream recharge along major tributaries including portions of Granite Creek, Lynx Creek and the Agua Fria River. Mountain front recharge is estimated to occur at a long-term fixed rate of 2,930 acre-feet per year along the periphery of the LIC and UAF Sub-basins. Observation data and groundwater modeling indicates that most natural recharge enters the groundwater flow system along major tributaries and ephemeral streams. Ephemeral stream channel recharge is temporally variable, and occurs during periods of moderate to significant stream flow along major tributaries.

Recent analysis of annual stream flow data conducted by ADWR provided updated estimates for years when significant stream flow was available for recharge on the major drainages in the PRAMA (Nelson, 2012). Based on this analysis, estimates of annual runoff to major drainages were input into the ADWR - PRAMA groundwater flow model to develop model-calculated estimates of stream channel recharge. The results of this effort generally indicated higher rates of sporadically applied ephemeral stream channel recharge provided a better model calibration. Based on the available data, periods of significant natural recharge from ephemeral stream flows occurred in the late 1970s and early 1980s, 1993 and the winter of 2004/2005. Alternatively, periods of minimal/negligible stream recharge occurred between the early and the mid-1960s, and from mid-1995 to late-2004 (Nelson, 2012). Annual estimates of natural recharge for the period from 1985 to 2010 are listed in Table 2-2. We believe the long-term average of ephemeral channel recharge reasonably captures the magnitude of this process. However, inherent data limitations limit/compromise the accuracy of the annual estimates.

Groundwater in the UAU and LVU flows from the Little Chino Sub-basin out of the PRAMA to the Big Chino Sub-basin northwest of Del Rio Springs. Some underflow may also occur in saturated carbonate rocks that underlie the western Sullivan Buttes in that same general area. Recent modeling results also indicate that some underflow may leave the Upper Agua Fria Sub-basin in the Humboldt area through and cracks in basement Unit rocks. Model estimates of net groundwater underflow out of the PRAMA in these areas are listed in Table 2-2.

TABLE 2-2
COMPONENTS OF NET RECHARGE (AF)
PRAMA 1985-2010

	Year	Natural Components of GW Recharge and Discharge					Incidental Recharge	Net Recharge [7]
		Mountain Front Recharge [1]	Stream Channel Recharge [2]	GW Underflow Outflow [3]	GW Discharge [4]	Riparian ET [5]	AG Recharge [6]	
Historical Period	1985	2,930	62	2,831	3,886	769	10,494	6,000
	1986	2,930	92	2,831	3,346	767	8,235	4,313
	1987	2,930	122	2,815	3,117	766	7,021	3,375
	1988	2,930	13,482	2,815	2,990	759	6,975	16,823
	1989	2,930	182	2,811	2,653	763	3,964	849
	1990	2,930	165	2,796	2,417	764	3,020	138
	1991	2,930	13,468	2,773	2,357	763	7,161	17,667
	1992	2,930	13,444	2,763	2,490	764	7,365	17,722
	1993	2,930	33,185	2,766	3,139	766	9,586	39,030
	1994	2,930	125	2,733	2,666	766	4,604	1,495
	1995	2,930	26,889	2,725	3,017	766	8,873	32,185
	1996	2,930	116	2,737	2,685	766	4,074	933
	1997	2,930	130	2,718	2,373	765	5,528	2,731
	1998	2,930	13,384	2,705	2,447	765	3,344	13,741
	1999	2,930	107	2,708	2,635	767	4,283	1,209
	2000	2,930	134	2,694	2,279	765	4,684	2,010
	2001	2,930	149	2,647	2,045	766	3,283	903
	2002	2,930	172	2,627	1,870	765	3,814	1,655
	2003	2,930	187	2,607	1,775	765	2,127	97
	2004	2,930	208	2,636	1,730	764	2,495	503
	2005	2,930	35,500	2,627	2,448	766	1,651	34,240
	2006	2,930	144	2,655	2,380	766	1,423	-1,303
	2007	2,930	164	2,662	2,148	765	1,934	-547
	2008	2,930	13,420	2,649	1,912	765	2,180	13,205
	2009	2,930	165	2,633	1,779	766	1,911	-172
	2010	2,930	23,738	2,629	2,098	766	1,228	22,403

Notes:
[1] Mountain Front Recharge Estimates from ADWR Prescott Model Update 2012.
[2] Stream Channel Recharge Estimates from ADWR Prescott Model Update 2012 (Includes Granite Creek, Lynx Creek and Agua Fria River).
[3] Groundwater Underflow Estimates from ADWR Prescott Model Update 2012 (Includes Outflow from LIC to BIC and UAF to AF).
[4] Groundwater Discharge Estimates from ADWR Prescott Model Update 2012 (Includes Del Rio Springs and Agua Fria River near Humboldt).
[5] Riparian ET Estimates from ADWR Prescott Model Update 2012 (Includes Del Rio Springs and Agua Fria River near Humboldt).
[6] Agricultural Recharge Estimates from ADWR Ag Water Use Data (Assumes Irrigation and Canal Recharge as 50% of Total AG Water Use).
[7] Net Recharge = All Recharge Components - All Discharge Components.

Groundwater discharge occurs in the Little Chino Sub-basin at Del Rio Springs and in the Upper Agua Sub-basin in the channel of the Agua Fria River near Humboldt. Model estimates of groundwater at these locations are listed in Table 2-2. Evapotranspiration occurs in riparian zones co-located in these areas where groundwater discharge occurs. Groundwater model estimates of riparian evapotranspiration are also listed in Table 2-2.

Estimated incidental recharge from agricultural irrigation in both the LIC and UAF Sub-basins is in Table 2-2. Incidental agricultural recharge was estimated at 50 percent of the total reported agricultural water applied from both groundwater and surface water sources (Corkhill & Mason, 1995). Comparison the agricultural recharge estimates presented in Table 2-2 to modeling estimates that also include CVID canal recharge were very similar. This is mainly due to the fact that both estimates assume 50 percent irrigation efficiencies for groundwater and surface water applied, and canal recharge was estimated to be zero after 1999, when the City of Prescott purchased the rights to water in Watson and Willow Lakes, and canal deliveries were discontinued to the CVID.

Table 2-3 presents projections of future groundwater recharge and discharge for the period 2011 to 2025. For the most part, these estimates were derived by extrapolating current estimated recharge and discharge rates into the future (Nelson, 2012). Projections of future ephemeral stream channel recharge were developed by analyzing historic “wet” and “dry” periods that included dry (1940-1953), average (1963-(1963-1976 and 1994-2007), and wet (1973-1986) epochs. Further information on these projections is provided in the water budget and planning sections presented Chapter 11 of this Plan.

TABLE 2-3
COMPONENTS OF NET NATURAL RECHARGE (AF)
PRAMA 2011-2025

	Year	Natural Components of GW Recharge and Discharge						Incidental Recharge	Net Recharge	
		Mountain Front Recharge	Stream Channel Recharge: Dry Scenario [2]	Stream Channel Recharge: Wet Scenario [3]	GW Underflow Outflow	GW Discharge	Riparian ET	AG Recharge	Dry Scenario	Wet Scenario
Projection Period [1]	2011	2,930	0	35,461	2,951	2,364	766	1,228	-1,923	33,538
	2012	2,930	30,033	0	2,951	2,339	766	1,228	28,135	-1,898
	2013	2,930	0	0	2,941	2,314	766	1,228	-1,863	-1,863
	2014	2,930	0	0	2,931	2,289	766	1,228	-1,828	-1,828
	2015	2,930	0	0	2,921	2,264	766	1,228	-1,793	-1,793
	2016	2,930	0	29,557	2,911	2,239	766	1,228	-1,758	27,799
	2017	2,930	0	26,858	2,901	2,214	766	1,228	-1,723	25,135
	2018	2,930	0	38,755	2,891	2,189	766	1,228	-1,688	37,067
	2019	2,930	0	0	2,881	2,164	766	1,228	-1,653	-1,653
	2020	2,930	0	26,190	2,871	2,139	766	1,228	-1,618	24,572
	2021	2,930	0	24,835	2,861	2,114	766	1,228	-1,583	23,252
	2022	2,930	0	0	2,851	2,089	766	1,228	-1,548	-1,548
	2023	2,930	0	0	2,841	2,064	766	1,228	-1,513	-1,513
	2024	2,930	24,677	0	2,831	2,039	766	1,228	23,199	-1,478
	2025	2,930	0	0	2,821	2,014	766	1,228	-1,443	-1,443

Notes:
[1] Projection Estimates Based on ADWR Modeling Section Analysis of Future GW Conditions in the PRAMA Dry Scenario From ADWR Modeling Section Analysis of 1940 to 1953 Time Period Wet Scenario From ADWR Modeling Section Analysis of 1973 to 1986 Time Period.
[2] Stream Channel Recharge Estimates from ADWR Prescott Model Update 2012 (Includes Granite Creek, Lynx Creek and Agua Fria River).
[3] Groundwater Underflow Estimates from ADWR Prescott Model Update 2012 (Includes Outflow from LIC to BIC and UAF to AF).

2.6 GROUNDWATER CONDITIONS

2.6.1 Sources of Groundwater Data

Aquifer water levels reflect the collective impacts of various applied stresses (pumping and recharge) and the influence of existing boundary conditions, including, but not limited to, the following: evapotranspiration, groundwater discharge to springs and streams, and groundwater underflow to and from adjacent groundwater basins. Groundwater level measurements provide important information on groundwater trends and changing aquifer storage conditions. Water level data has collected for many years from a number of wells in the PRAMA, including a few with records dating back to the 1930s and 1940s. The ADWR Hydrology Division's Field Services Section - Basic Data Unit collects groundwater-level data using both conventional field methods and automated technology.

Annual water-level measurements are collected manually from a select group of wells across the state referred to as Index Wells. Basic Data staff collects data from these wells using electric sounders or steel tapes facilitating collection of discrete measurements on a specified schedule (normally, annual water level measurements are made between January and March in the PRAMA). Between 2000 and 2010, ADWR collected an average of 169 water level measurements per year in the PRAMA. ADWR also collects continuous water-level data at dedicated index well sites using automated groundwater monitoring devices (transducers, bubblers and shaft encoders) that take measurements on a predefined frequency. ADWR uses both real-time (satellite-linked) and non-real-time automated recording systems. ADWR currently maintains and operates 16 automated water level monitoring sites in the PRAMA. All water-level data collected by ADWR's Basic Data Unit are uploaded and stored in the ADWR's Groundwater Site Inventory (GWSI) database. Figure 2-3 shows both index well and automated site locations within the PRAMA as of 2012.

2.6.2 Water Level Trends (1994 to 2009/2010)

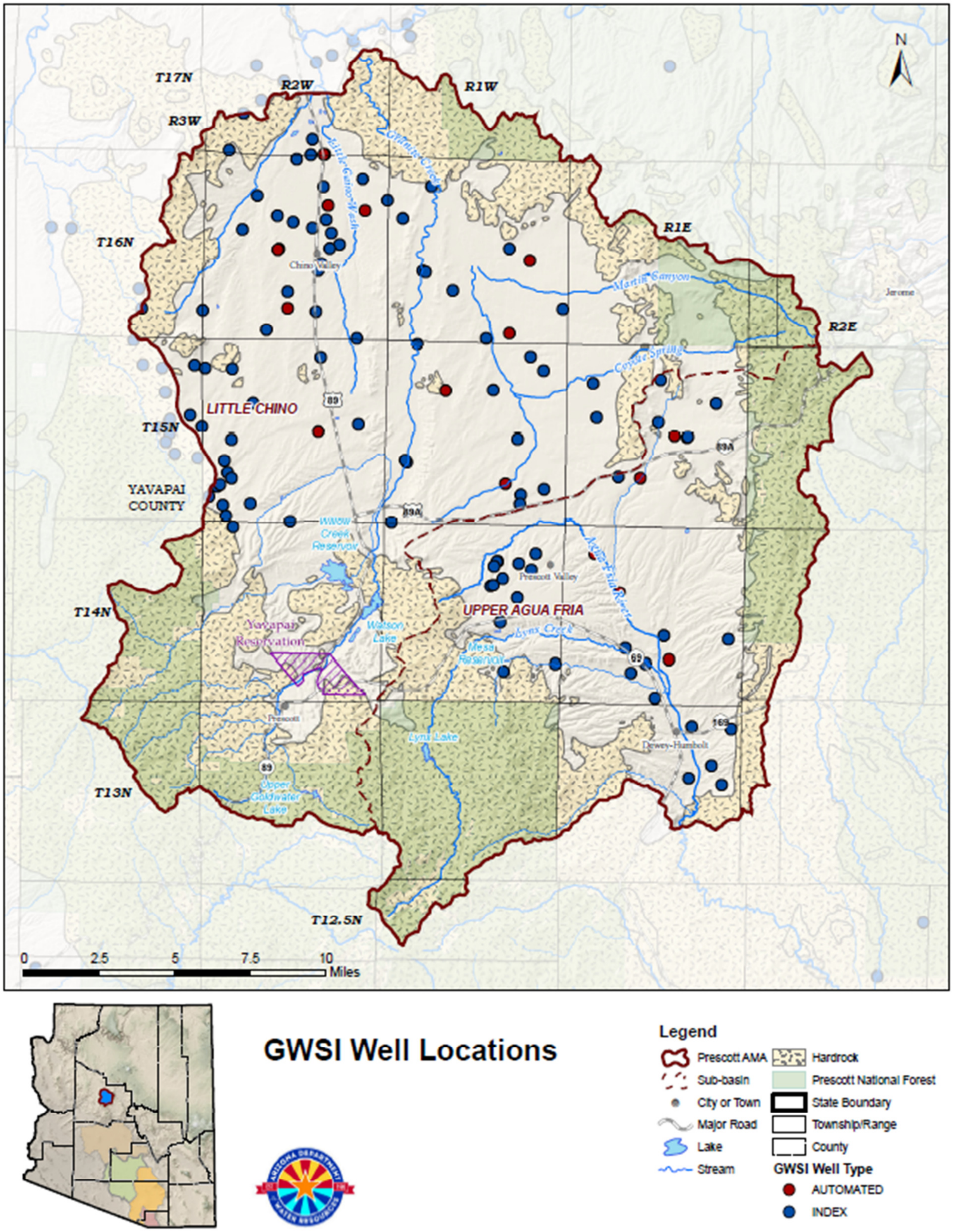
From 1994 to 2010, water levels were impacted by several important factors, including: groundwater withdrawals; recharge from flood flows on major drainages; recharge of treated reclaimed water by the of Prescott, the Towns of Prescott Valley and Chino Valley; and drought. Water levels were measured in wells in the LIC and 20 wells in the UAF Sub-basins between 1994 and 2009/2010. Analysis of the data these wells evidences that 31 of the 35 wells measured in the LIC Sub-basin experienced water level declines, with an average rate of water level decline of -1.4 feet/year over the period from 1994 to 2009/2010. The 4 wells that experienced water level rises in the LIC for the same period had an average of rise of +0.9 feet/year. The average rate of water level decline for the 14 wells that declined in the UAF Sub-basin was -1.4 feet/year and the average rate of water level rise for the 6 wells showing rises was feet/year (Figure 2-4). Representative hydrographs from selected wells are shown in Appendix 2-1. Additional information concerning water level changes in the PRAMA, and in other areas of the State, be found in ADWR's 2012 Statewide Hydrologic Monitoring Report (ADWR, 2012).

Trends in measured water levels reflect the aquifer system's collective response to a number of important factors which include:

- Overall water use (groundwater and surface water, as it may impact groundwater use)
- Incidental recharge (from groundwater and surface sources)
- Precipitation and natural recharge
- Artificial recharge activities
- Use of reclaimed water (as it may replace existing groundwater use)
- Water conservation

Water level trends in the PRAMA for the period from 1994 to 2010 include declining water levels in most of the PRAMA and significant water level recovery in one area where a major change in municipal pumping patterns occurred (Figure 2-4).

FIGURE 2-3
INDEX AND AUTOMATED WELL LOCATIONS
PRESCOTT ACTIVE MANAGEMENT AREA



In the northern part of the Little Chino Sub-basin north of the Town of Chino Valley, water levels were observed to decline about 20 to 30 feet over the period from 1994 to 2010 (see Appendix 2-1, Figures 2-2-7B, 2-7F and 2-7G, for example). Water level declines in this area were mainly caused by groundwater pumping at the City of Prescott's Chino Valley well field and by agricultural, minor industrial and pumping in the same general area. Historically, groundwater pumping in this area has caused once artesian wells to cease flowing and groundwater discharge from Del Rio Springs to decline (United States Geological Survey, 2012). East of Chino Valley, as shown in Appendix 2-1, Figure 2-7E, a well located along Granite Creek showed impacts of recharge from sporadic storm flow events in 1993 and 2005. Further south along Granite Creek near the City of Prescott's Airport Recharge facility, shallow wells showed water level rises due to the combined impacts of recharge of treated reclaimed water at the site (in Appendix 2-1, Figure 2-7I) and sporadic flood flows on Granite Creek. However, deeper wells completed in the confined LVU basin-fill aquifer in that same area showed declines of over 20 feet during the same time period in response to municipal, agricultural and industrial pumping from this unit.

In the southwestern portion of the Little Chino Sub-basin, near Granite Mountain and Williamson Valley Road, water levels were observed to decline by 10 to 60 feet, or more between the years 2000 and 2012, in wells drilled in basin-fill and/or fractured bedrock formations (see Appendix 2-1, Figure 2-7K, for example). Water level declines in this area are primarily due to domestic and small water company pumping. However, prolonged drought reducing local natural recharge in the area has likely also contributed to the overall decline.

In the northern part of the Upper Agua Fria Sub-basin, water levels have recovered by 200 feet or more in some deep municipal wells located in the Prescott Valley-Santa Fe well field (see Appendix 2-1, Figure 2-7M). Recoveries at the Santa Fe well field are due to the construction and operation of several new municipal wells in the Prescott Valley-North well field, located a few miles to the north in Lonesome Valley. The construction of the new wells has allowed Prescott Valley to distribute, balance, and optimize pumping operations over its service area. Water level declines in other parts of the Prescott Valley area were generally in the range of 11 to 38 feet (see Appendix 2-1, Figure 2-7N). In the northeastern portion of the Upper Agua Fria Sub-basin water levels declined by 7 to 10 feet in the Coyote Springs area (see Appendix 2-1, Figure 2-7J). Declines in this area were believed to be a consequence of a combination of local domestic pumping and reductions in natural recharge because of drought.

Water level declines were observed in most other portions of the central and northern sections of the Upper Agua Fria Sub-basin. However, impacts of sporadic recharge of flood flows on Lynx Creek and the Agua Fria River were observed in the hydrographs of some wells located close to those drainages (see Appendix 2-1, Figure 2-7O). The water level in well A-13-01 02CAD (Appendix 2-1, Figure 2-7Q) located along the Agua Fria River near Dewey rose by roughly 3 feet from 1994 to 2010 and provides evidence of the influence of periodic flood recharge and more gradual recovery that may be associated with reductions in local agricultural pumping and artificial recharge from the Town of Prescott Valley's Upper Agua Fria Recharge facility.

2.6.3 2010 Water Level Elevation and Depth-to-Water Maps

The 2010 water level elevation map for the PRAMA is shown in Figure 2-5. The water level elevation map displays the elevation of the water table above mean sea level. The general direction of groundwater flow in an aquifer is inferred by the orientation of the contours on a water level elevation map. A general rule of thumb to use when interpreting these maps is that groundwater flows from higher to lower elevations, and the direction of flow is at right angles to the water level elevation contours.

Depth-to-water in 2010 is shown in Figure 2-6. The 2010 depth-to-water map demonstrates the depth of the water table below land surface and provides information typically used for well design and hydrologic interpretation purposes.

2.6.4 Estimated Groundwater-In-Storage

Information on aquifer thickness, depth-to-water, and aquifer storage properties are commonly employed estimate the volume of groundwater in storage in an aquifer. The volume of groundwater storage in the PRAMA to a depth of 1,000 feet below land surface range from 3 to 5.2 million acre-feet (Corkhill & Mason, 1995), (Hipke, 2012). Although the volume in storage is seemingly large as compared to annual groundwater pumping, it should be realized that not all of that volume could be practically produced by groundwater withdrawals from wells. Hydrologic and technical issues that ultimately limit the actual volume of groundwater that can be produced include, but are not limited to:

- Aquifer productivity and heterogeneity
- Costs to drill new wells
- Increasing pumping costs and decreasing well yields with increasing depth-to-water
- Physical availability requirements under the Assured Water Supply Program
- Legal restrictions on well locations
- Water quality
- Land subsidence

FIGURE 2-4
WATER LEVEL CHANGE 1994 TO 2010
PRAMA

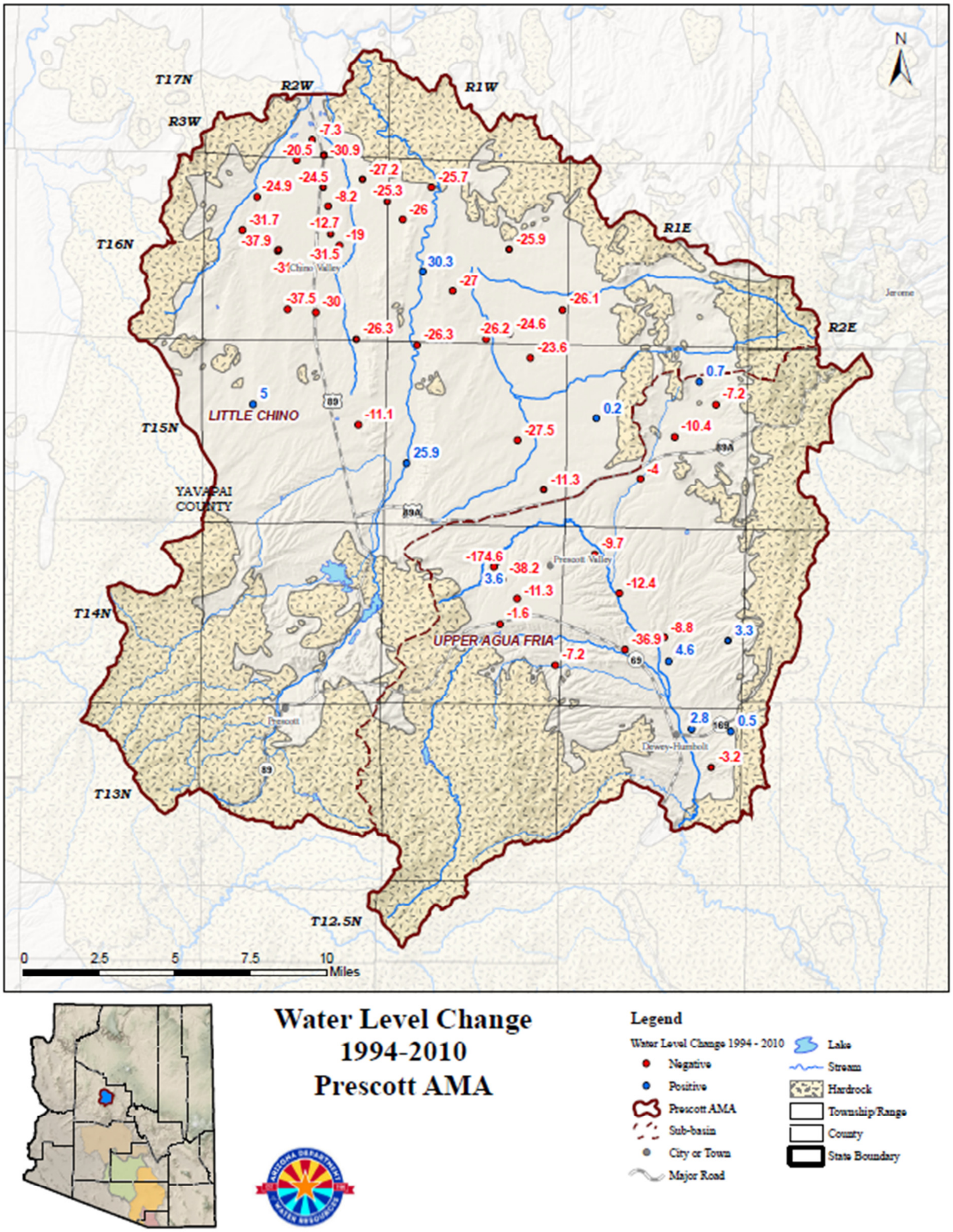
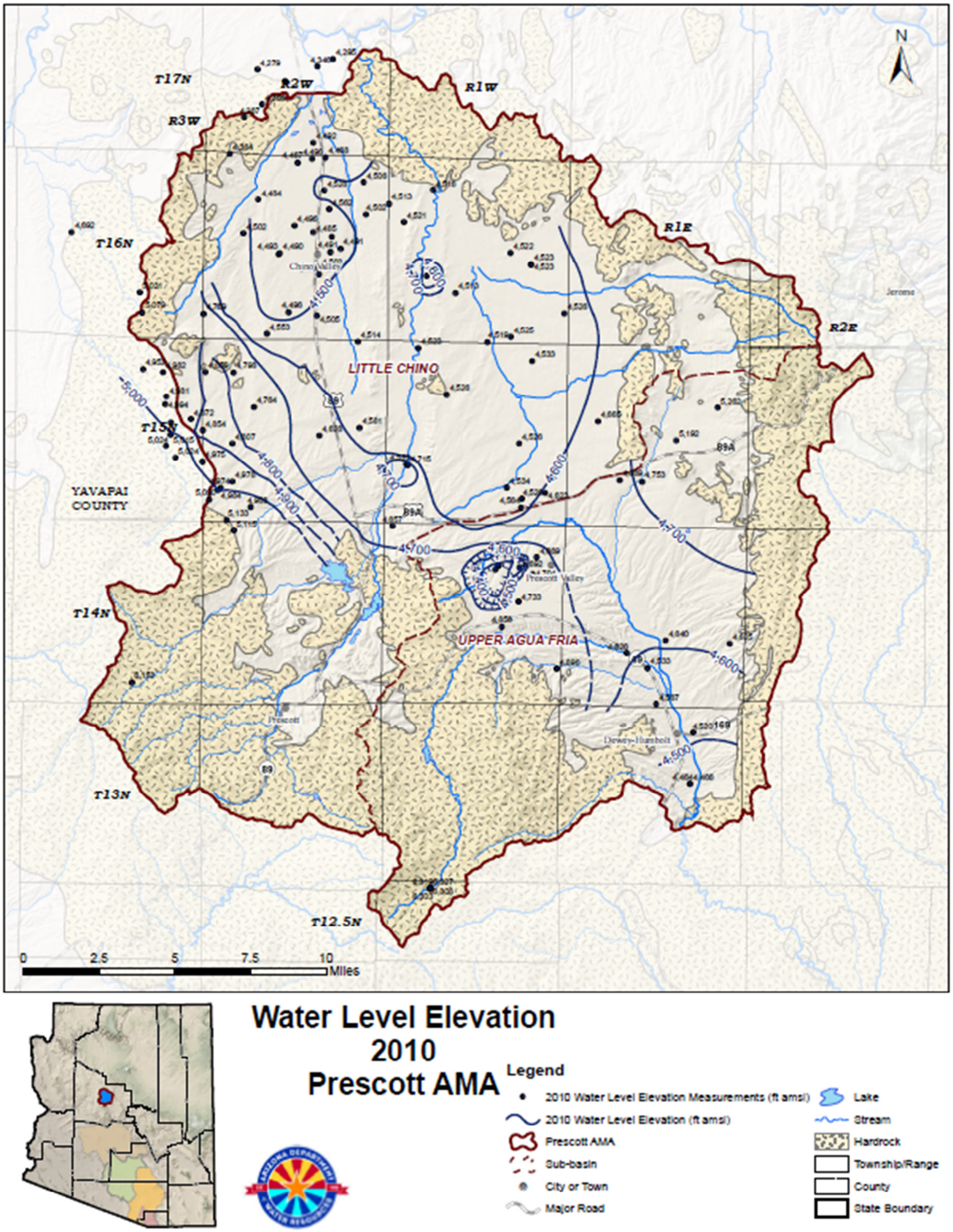
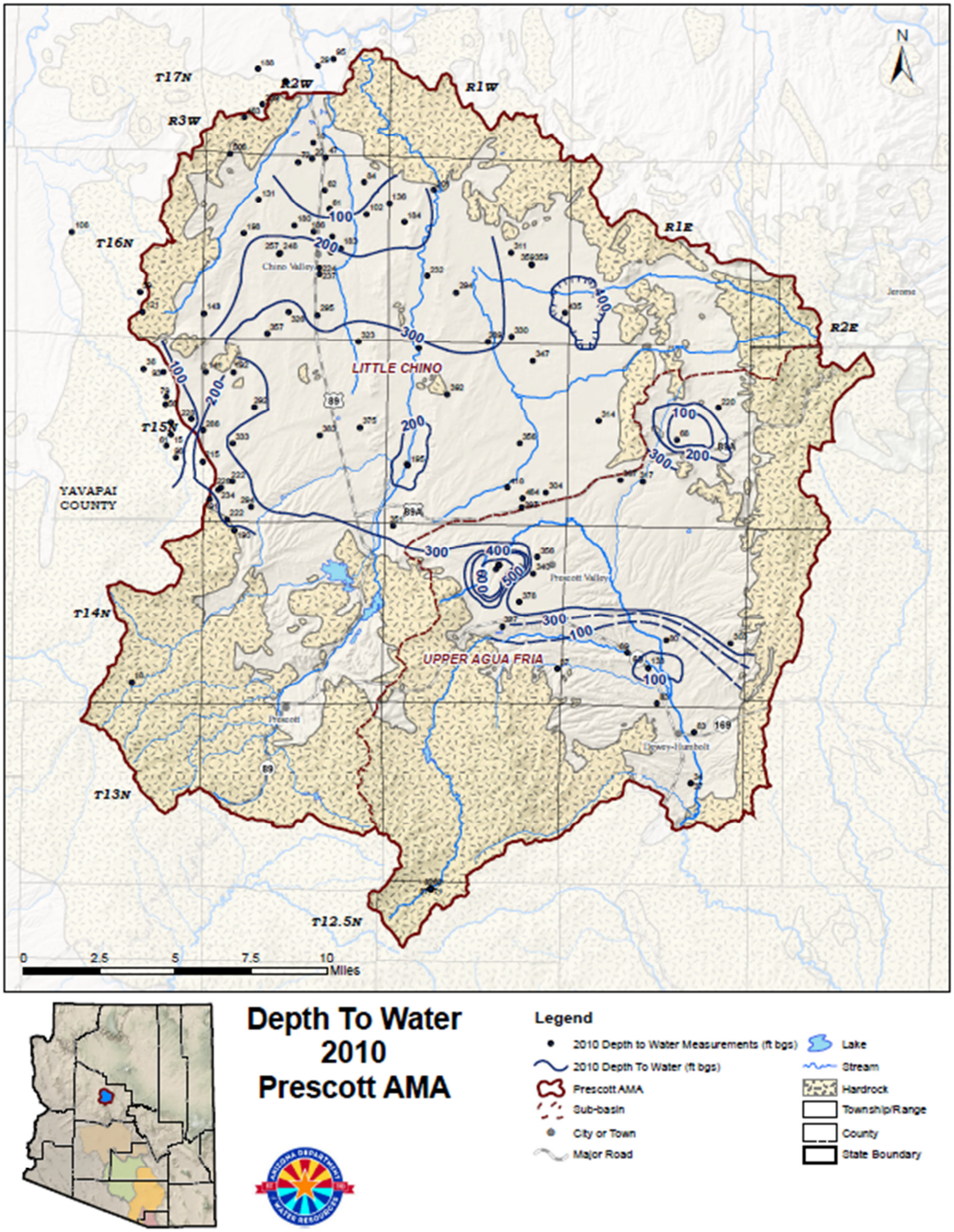


FIGURE 2-5
2010 WATER LEVEL ELEVATION
PRAMA



December 23, 2013 DRAFT

FIGURE 2-6
2010 DEPTH-TO-WATER
PRAMA



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APPENDIX 2-1
SELECTED HYDROGRAPHS
PRAMA

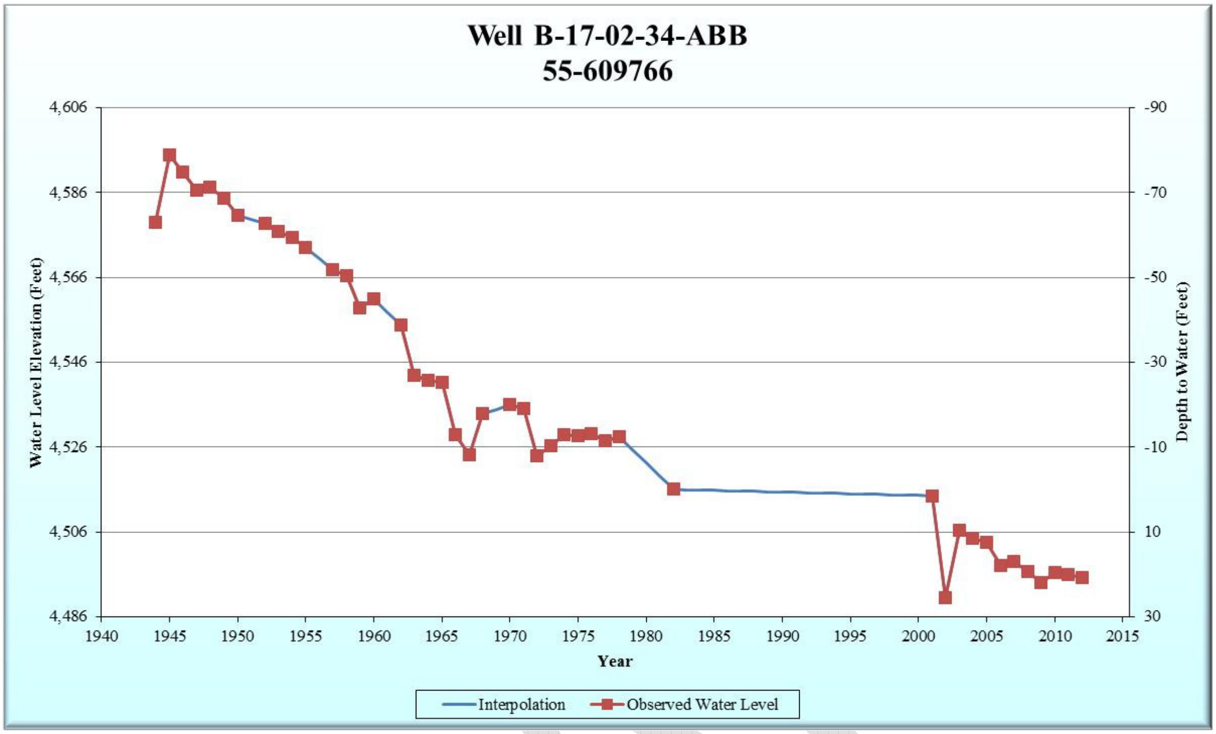

Figure 2-7A B-17-02 34ABB PRAMA - Little Chino Sub-Basin about 1.3 miles south of Del Rio Springs. Well was originally a flowing artesian well. Reduction in hydraulic head due to historic irrigation and municipal pumping reduced water level in the well to below the land surface.

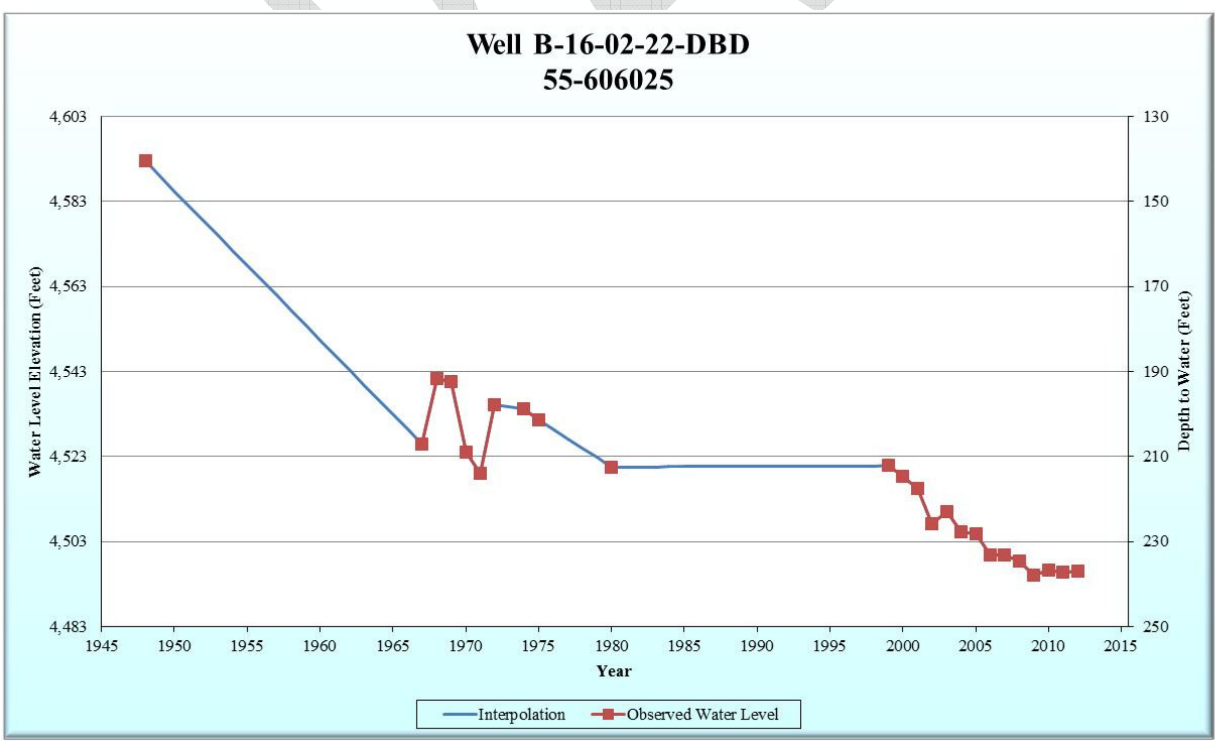

Figure 2-7B B-16-02 22DBD PRAMA – Southern part of Little Chino Sub-Basin agricultural area. Historic water level declines are caused by combination of agricultural and municipal pumping.

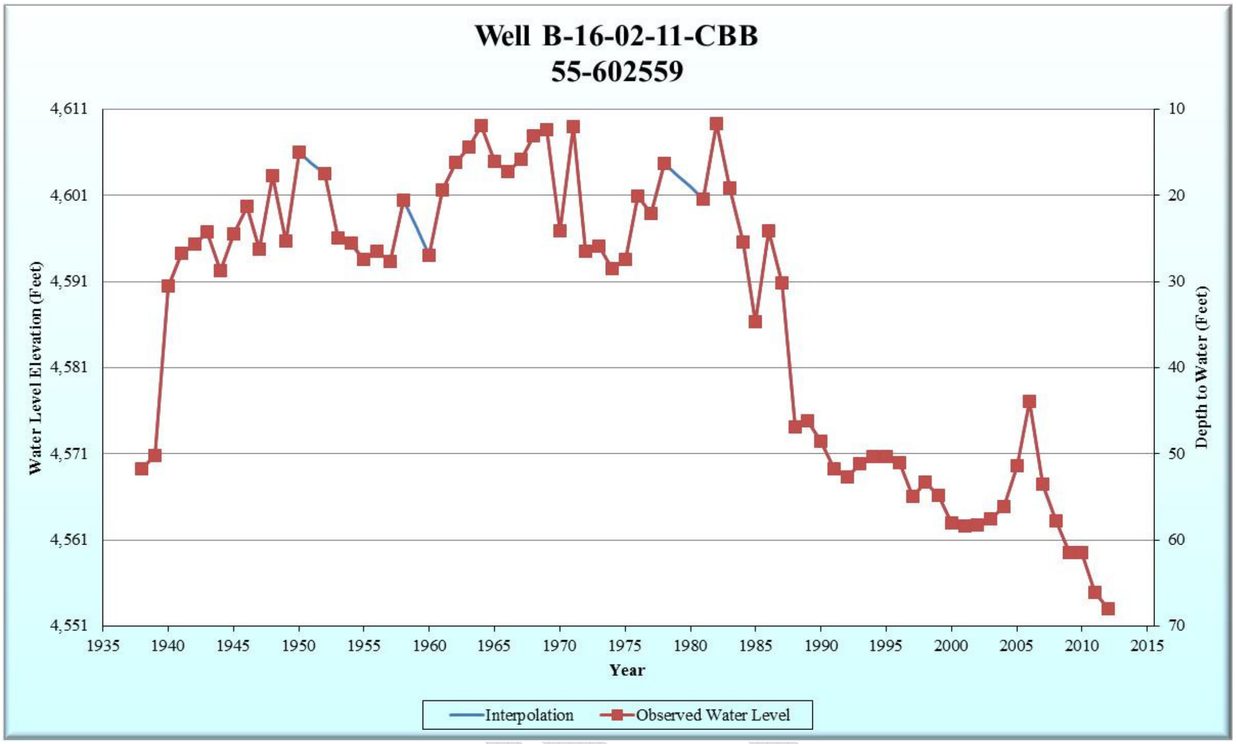

Figure 2-7C B-16-02 11CBB1 PRAMA – Shallow well in Little Chino Sub-Basin agricultural area showing "reverse" water table response due to agricultural recharge. Reductions in agricultural activity (using both groundwater and surface water supplies) in recent years have caused water levels to decline as the incidental recharge has diminished.

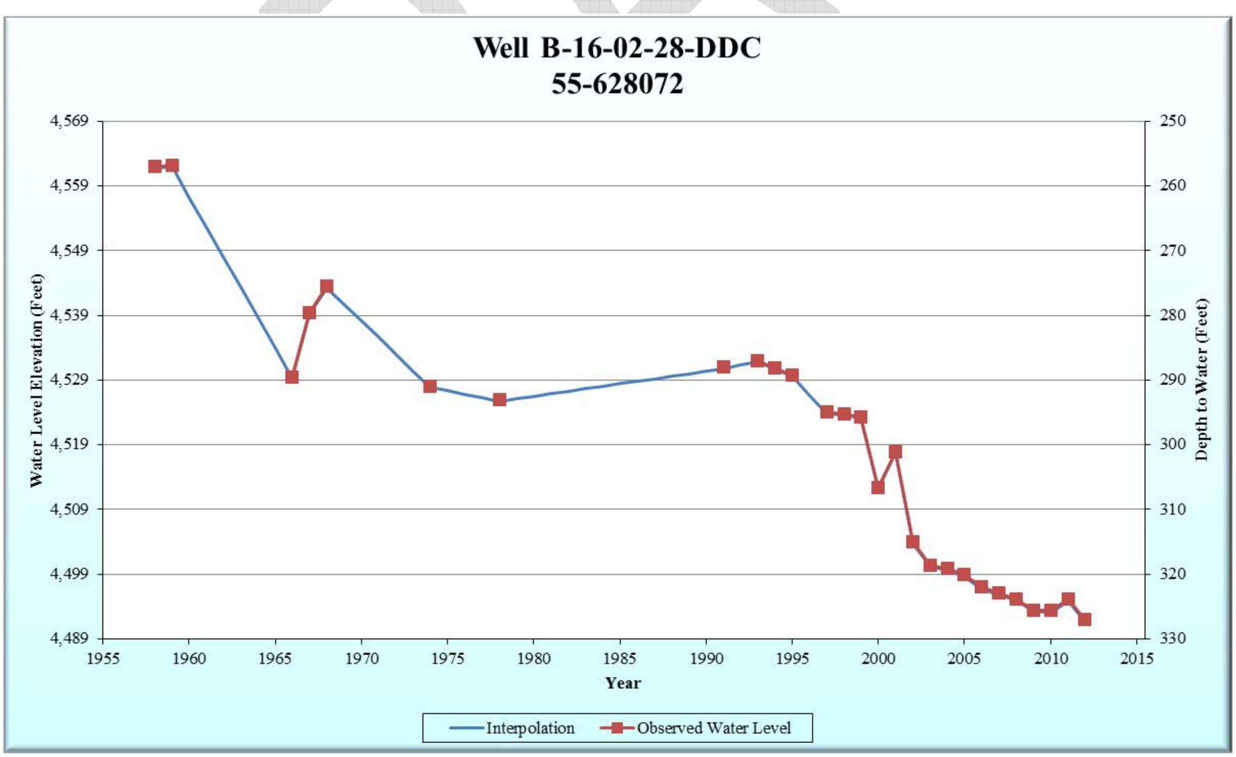

Figure 2-7D B-16-02 28DDC PRAMA – Southern part of Little Chino Sub-Basin farming area. Historic water level declines are caused by combination of agricultural and municipal pumping.

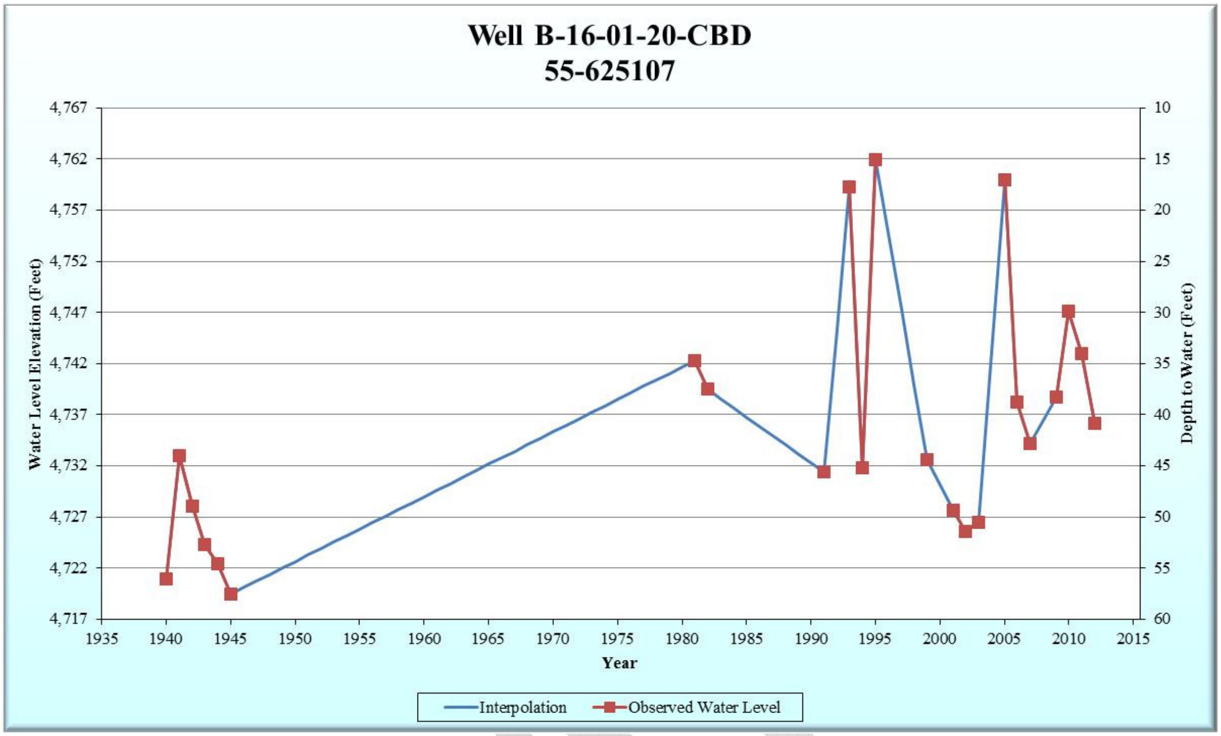

Figure 2-7E B-16-01 20CBD1 PRAMA – Northern area of Little Chino Sub-Basin near Granite Creek. Water levels show periodic rises due to flood recharge.

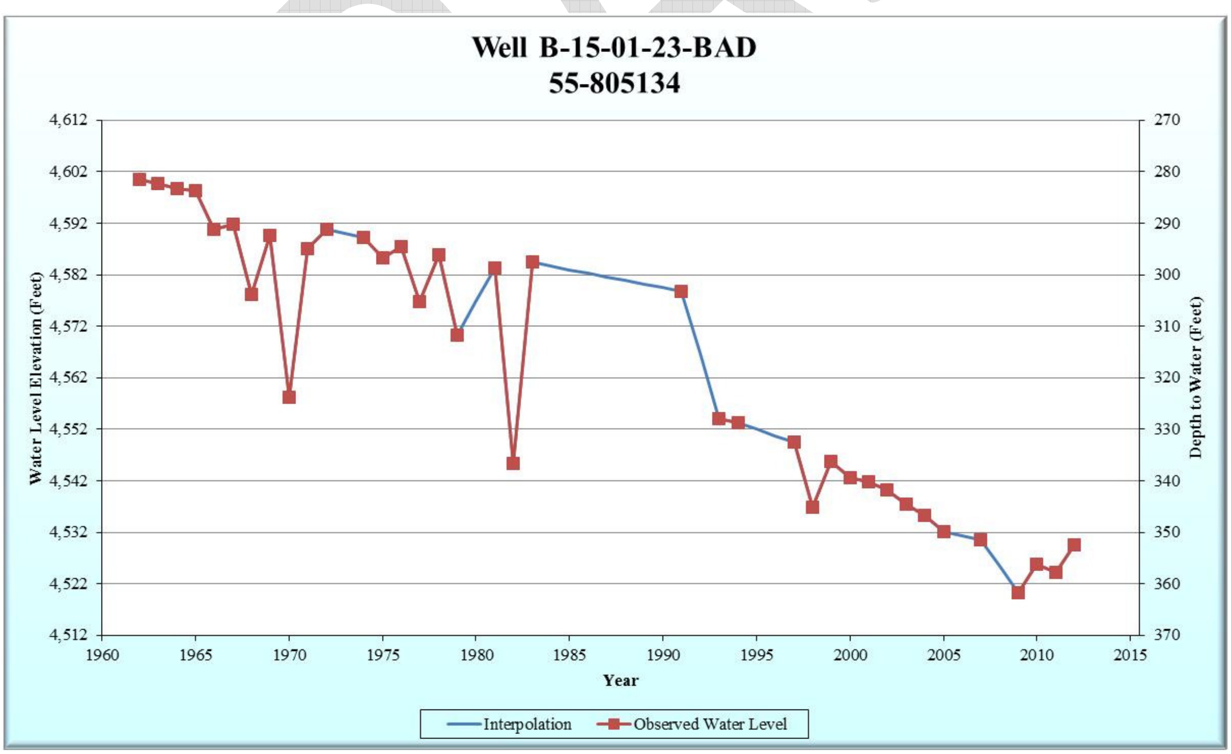

Figure 2-7F B-15-01 23BAD PRAMA – This well is located in the southern Lonesome Valley area of Little Chino Sub-Basin. Historic water level declines are caused by a combination of regional agricultural and municipal pumping and local pumping.

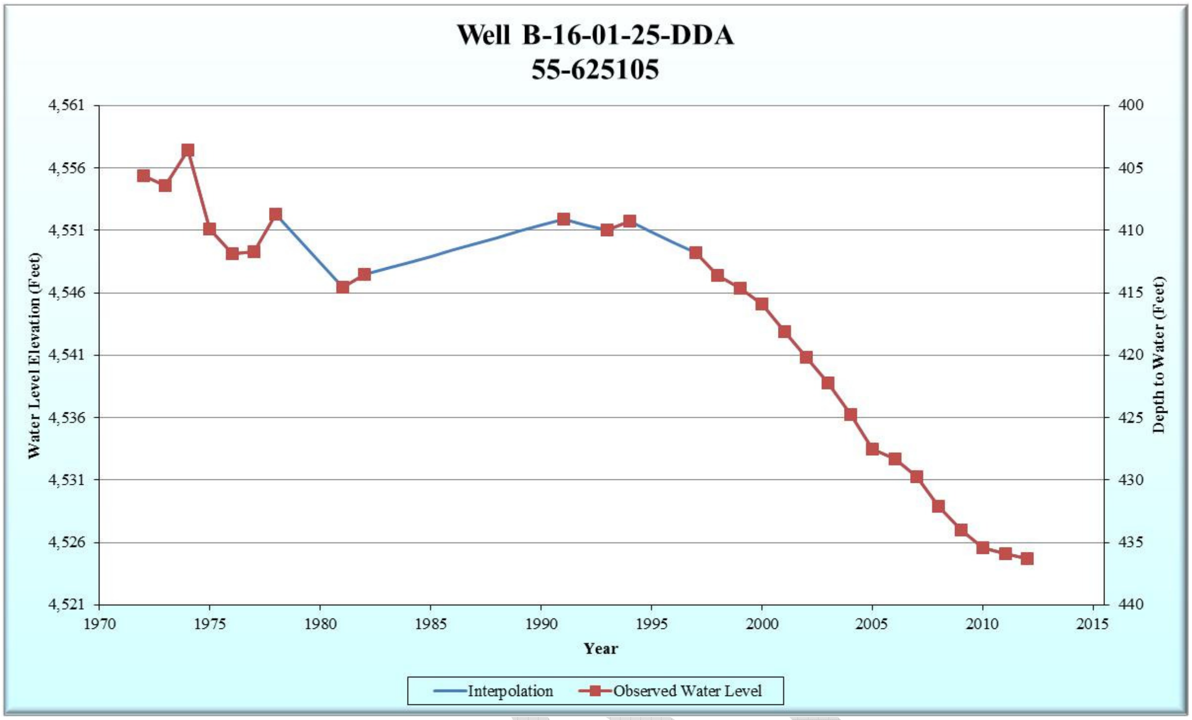

Figure 2-7G B-16-01 25DDA PRAMA – this well is in the NE Lonesome Valley area of Little Chino Sub-Basin. Historic water level declines are caused by a combination of regional agricultural and municipal pumping and local pumping.

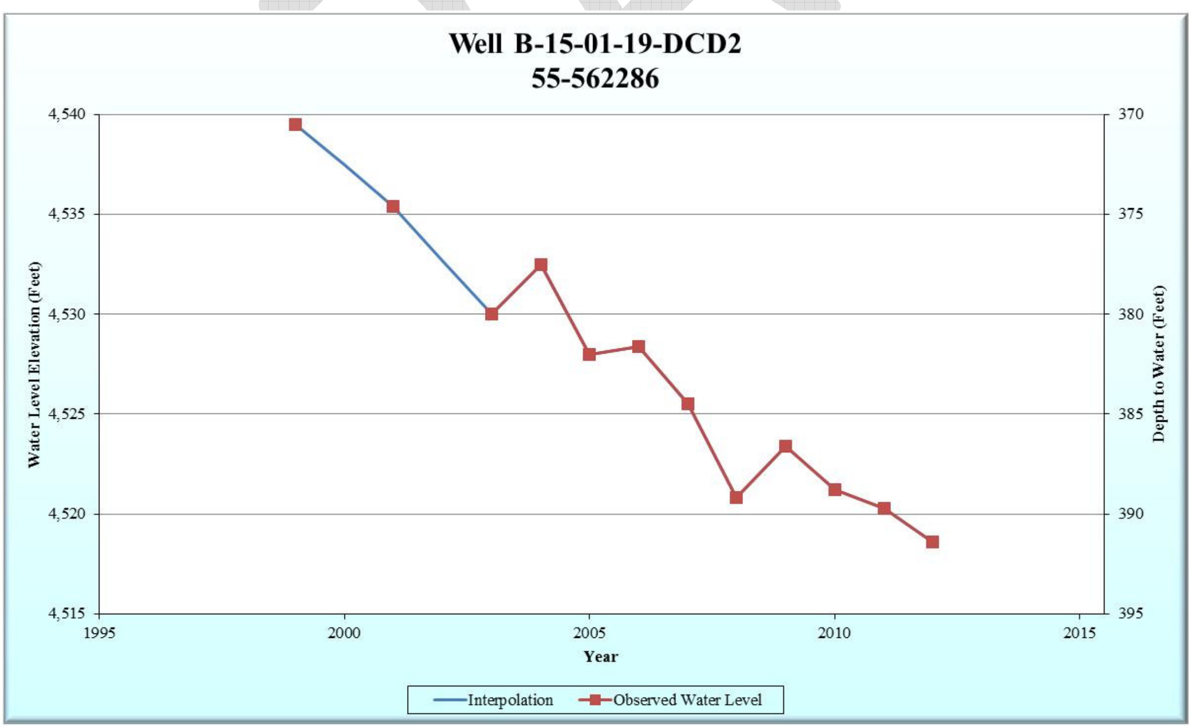

Figure 2-7H B-15-01 19DCD2 PRAMA – Little Chino Sub-Basin near Prescott Airport along Granite Creek. Deep well showing water level declines is due to local and regional groundwater withdrawals and little or no evidence of recharge from flood events or recharge of reclaimed water at the nearby City of Prescott Airport Recharge facility.

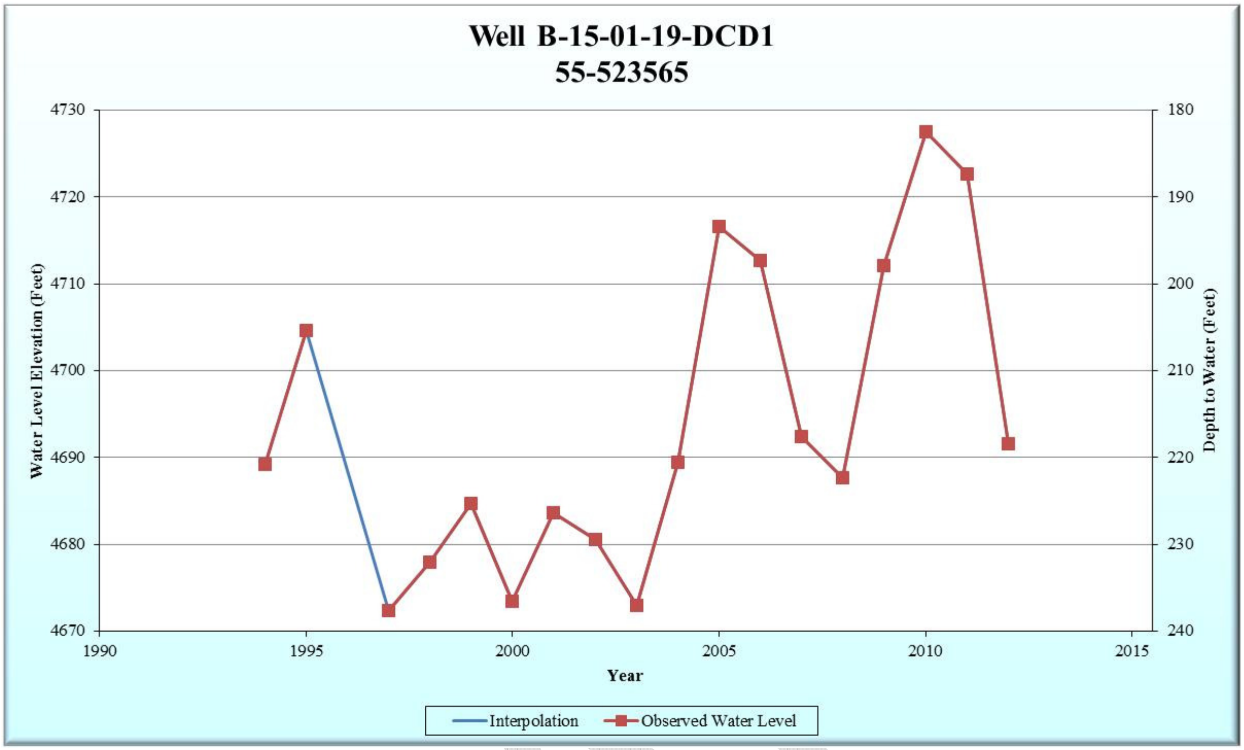

Figure 2-7I B-15-01 19DCD1 PRAMA – This well is in the Little Chino Sub-Basin near Prescott Airport along Granite Creek. This shallow well shows evidence of flood recharge and recharge of reclaimed water at the nearby City of Prescott Recharge facility.

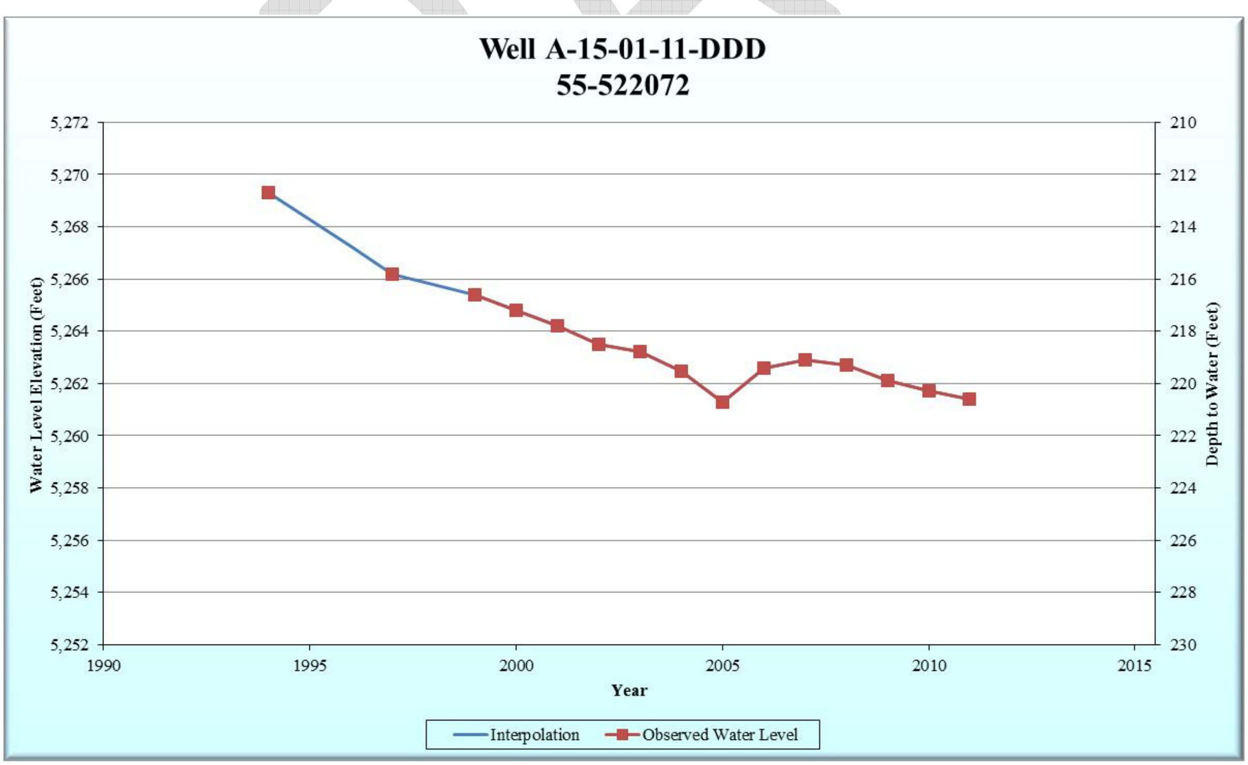

Figure 2-7J A-15-01 11DDD Prescott AMA – Coyote Springs/Indian Hills area of Upper Agua Fria Sub-Basin. Water level declines believed to be caused by local pumping and local reductions in natural recharge due to drought.

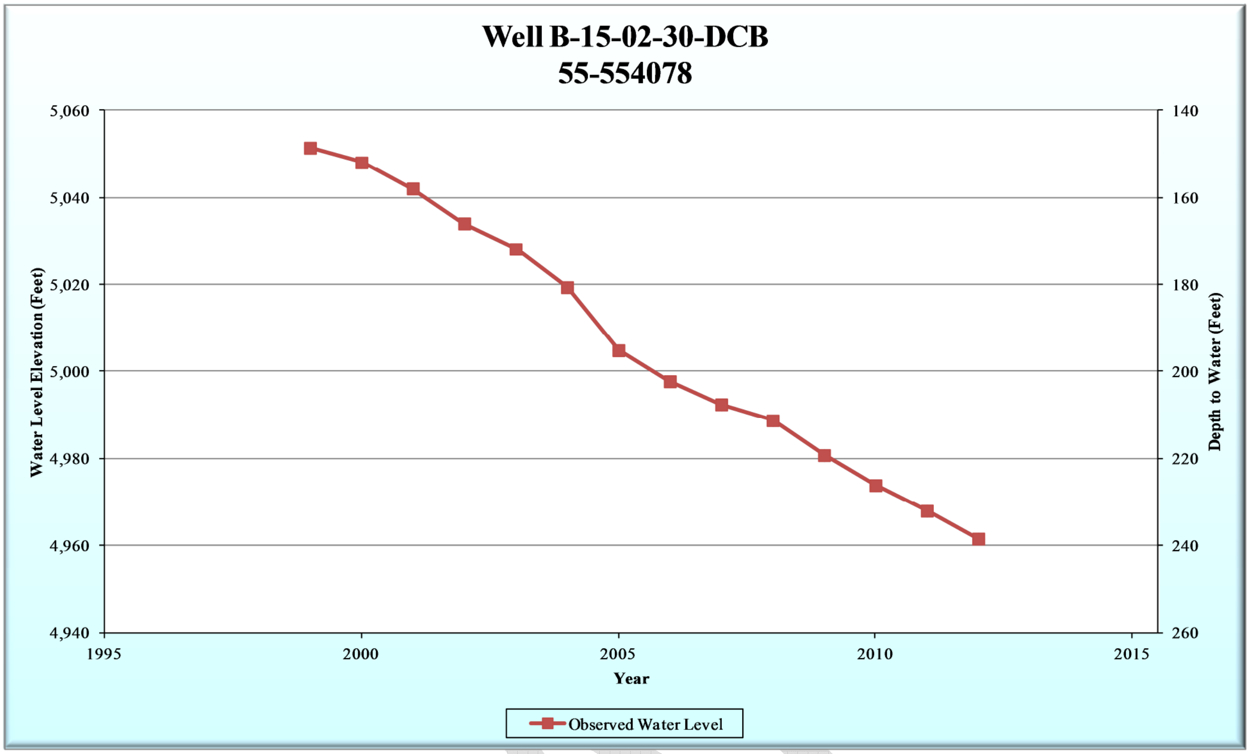

Figure 2-7K B-15-02 30DCB PRAMA – Little Chino Sub-Basin near Granite Mountain along Williamson Valley Road. Local domestic and municipal pumping believed to be primary cause of water level declines.

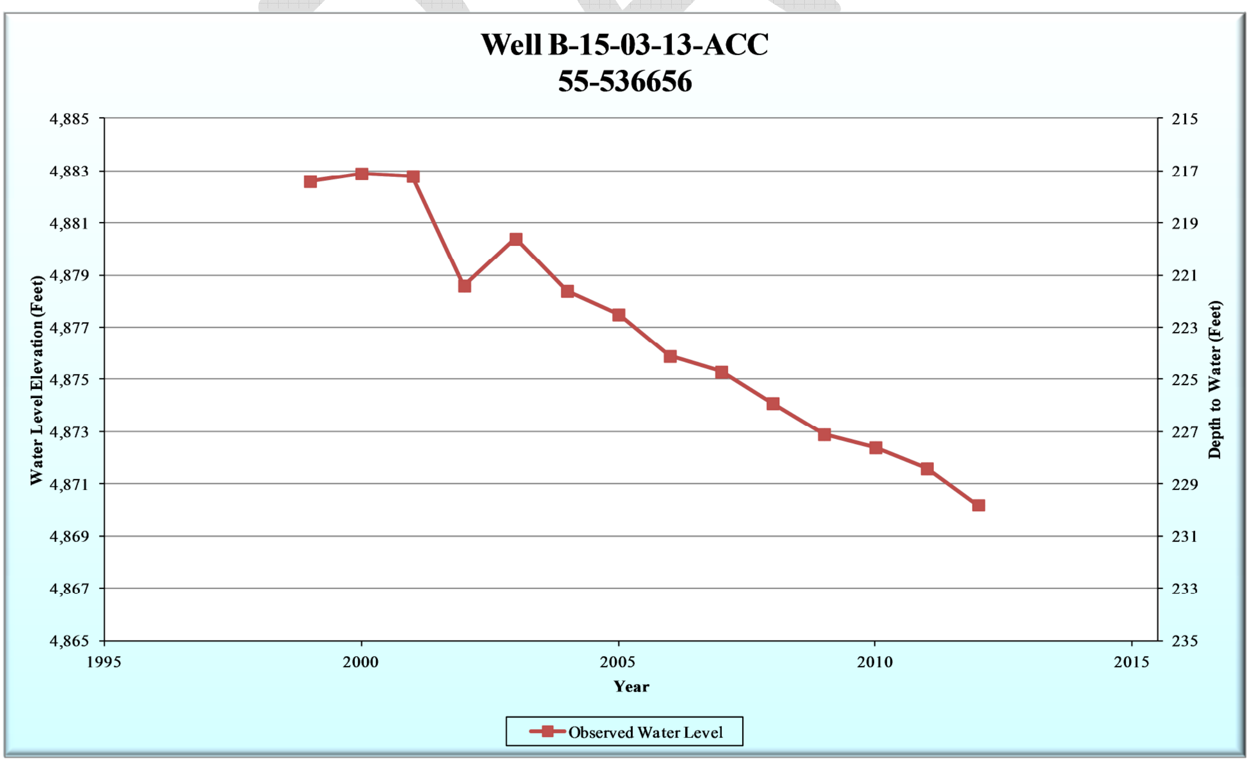

Figure 2-7L B-15-03 13ACC PRAMA – SW portion of Little Chino Sub-basin near American Ranch. Local domestic and municipal pumping believed to be primary cause of water level declines.

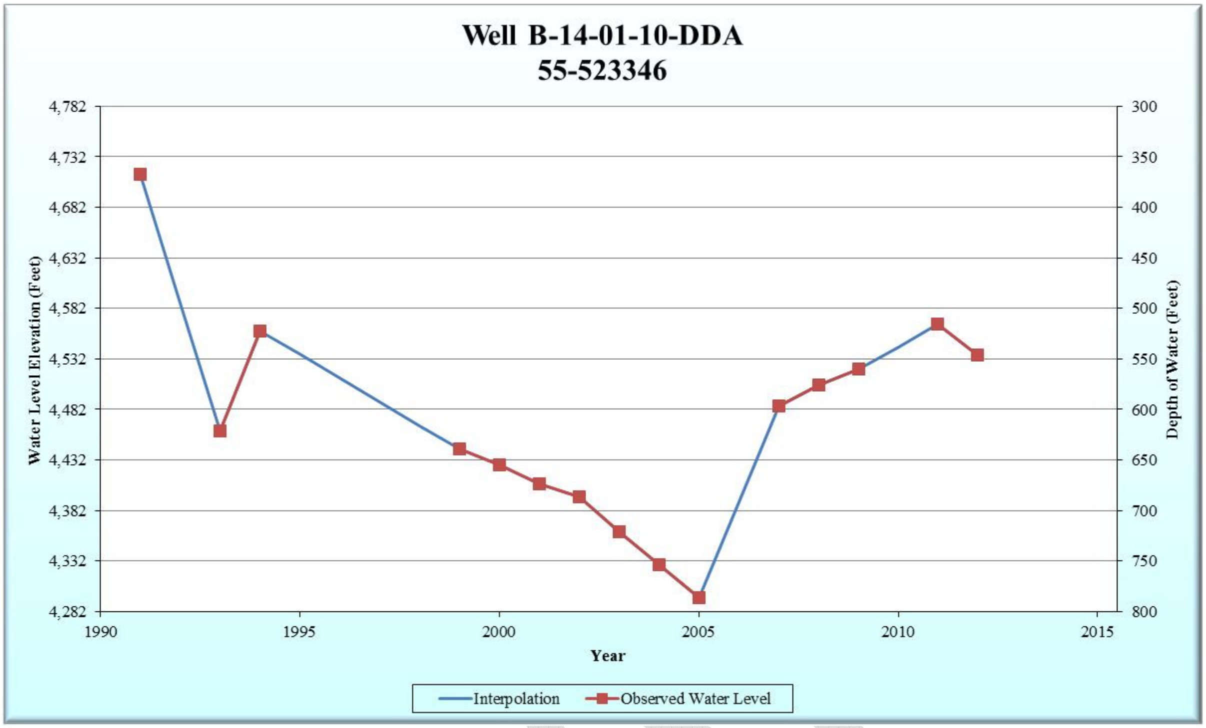

Figure 2-7M B-14-01 10DDA PRAMA – Prescott Valley Santa Fe Well Field area of Upper Agua Fria Sub-Basin. Recovery in water levels since 2005 due to shifting of pumping to newly developed Prescott Valley's "North" well field.

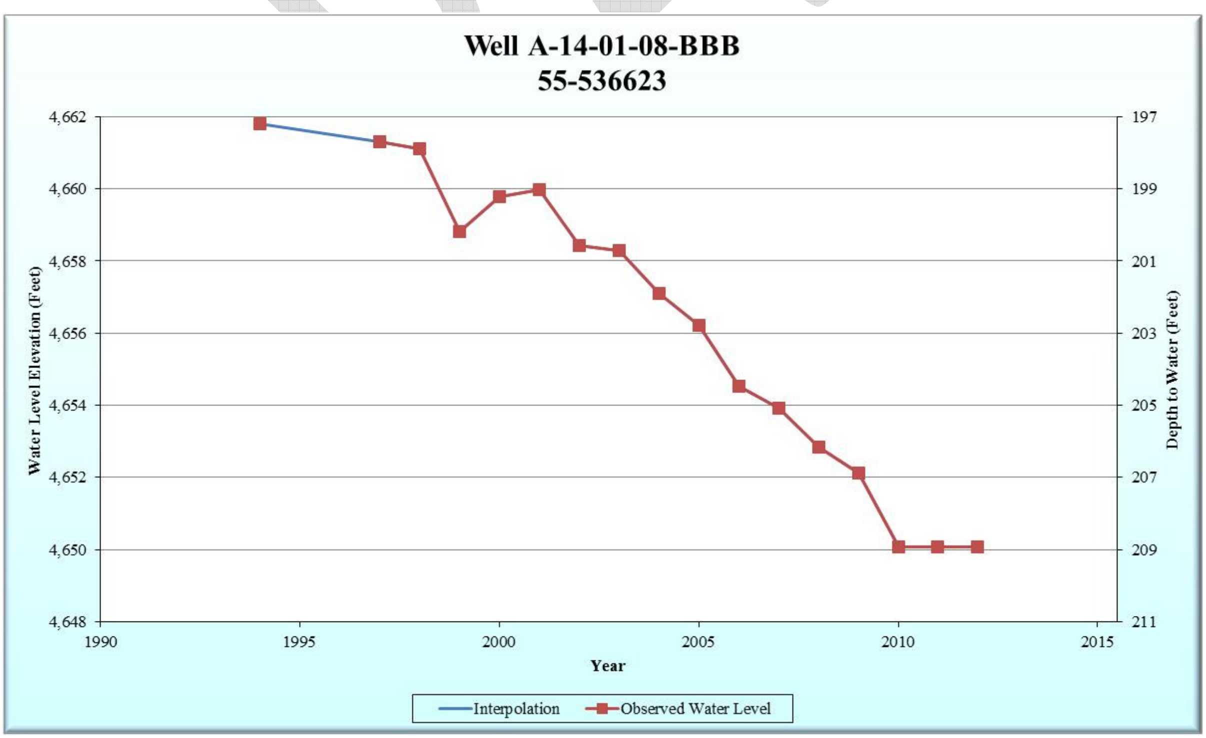

Figure 2-7N A-14-01 08BBB PRAMA – This well is in north-central Prescott Valley area of Upper Agua Fria Sub-Basin. Water level declines due to local and regional pumping.

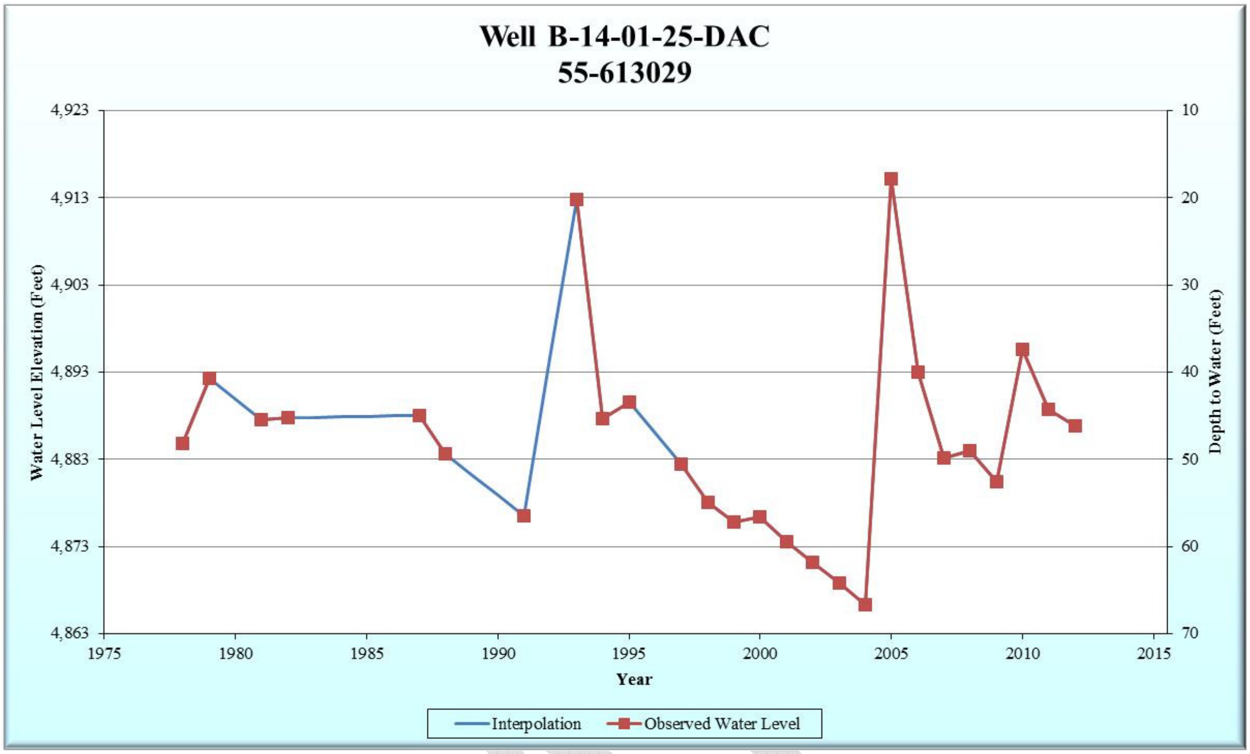

Figure 2-7O B-14-01 25DAC PRAMA – Southern Prescott Valley area 1 mile south of Lynx Creek in Upper Agua Fria Sub-Basin. Water level peaks in 1993 and 2005 correspond to significant flow events along Lynx Creek.

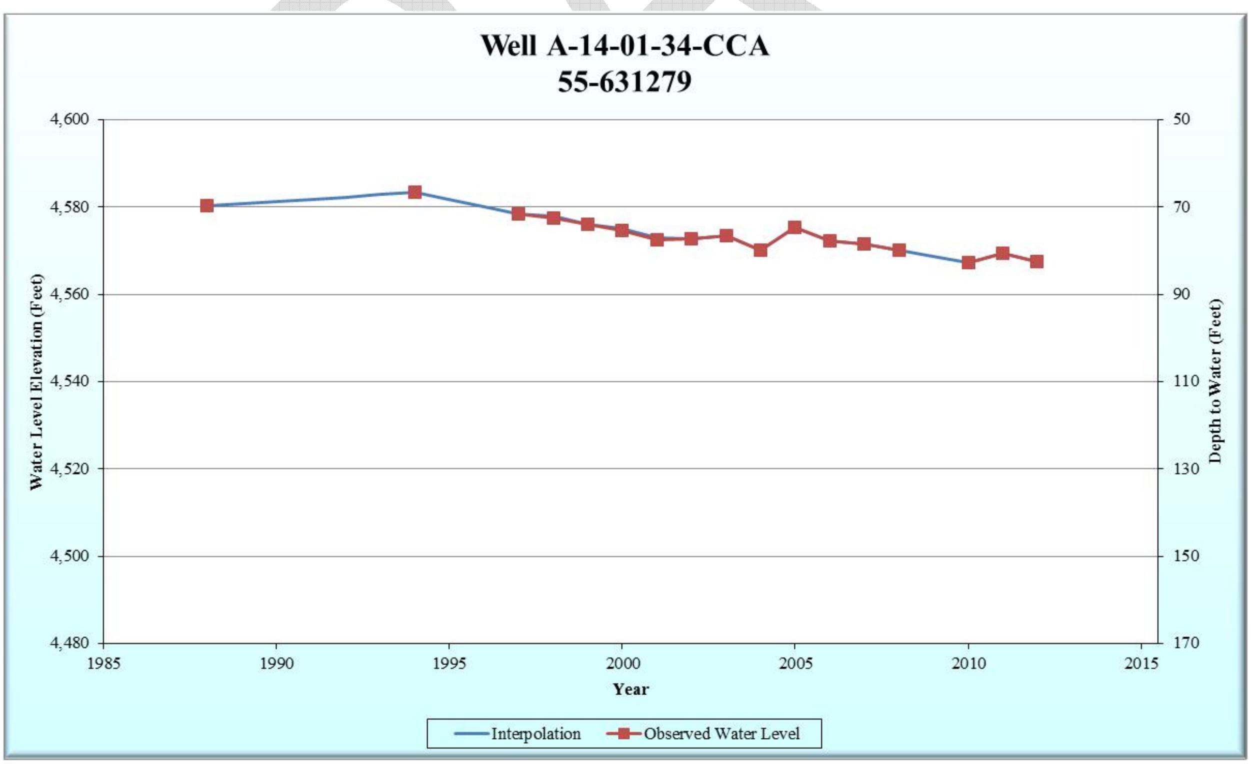

Figure 2-7P A-14-01 34CCA PRAMA – Upper Agua Fria Sub-Basin near confluence of Agua Fria River and Lynx Creek. Water level declines due to local and regional pumping.

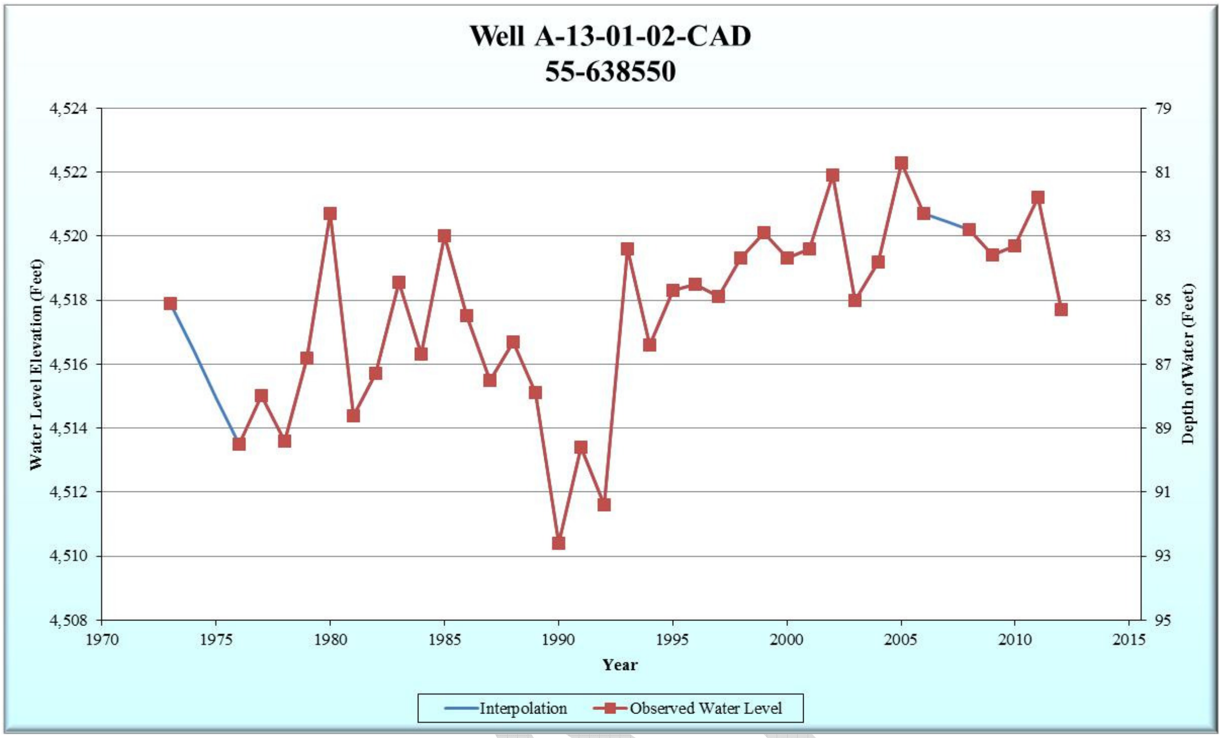

Figure 2-7Q A-13-01 02CAD PRAMA – Upper Agua Fria Sub-Basin about .25 miles east of Agua Fria River near Dewey. Peaks in water levels generally correspond to high flow events in those years. Recent gradual increase in water levels may reflect impacts of reduced agricultural activity in general area. Prescott Valley artificial recharge activities may also contribute to recovery trend in more recent years.

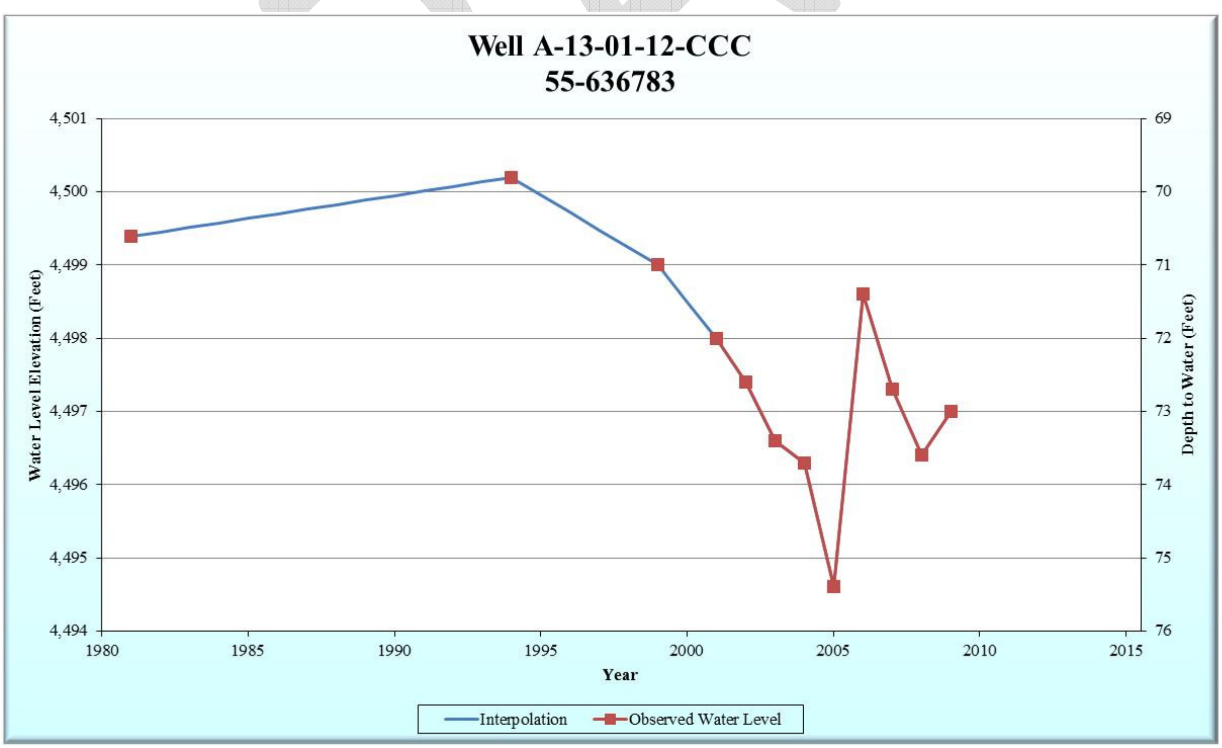

Figure 2-7R A-13-01 12CCC PRAMA – This well is in the Upper Agua Fria Sub-Basin east of the Agua Fria River near Humboldt.